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OFFICE OF CHEMICAL SAFETY
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MEMORANDUM

SUBJECT: Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba

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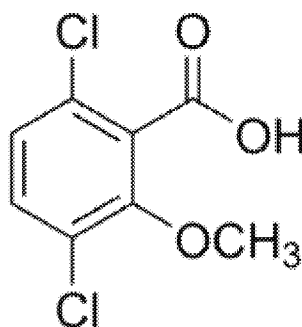
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Office of Chemical Safety
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**Problem Formulation for the Environmental Fate, Ecological Risk,
and Drinking Water Exposure Assessments in Support of the
Registration Review of Dicamba**



3,6-Dichloro-*o*-anisic acid, salts and esters

CAS Registry Number: 1918-00-9

PC Codes: 029801, 029802, 029803, 029806, 128931, 128944, 129043

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1. Executive summary

The Environmental Fate and Effects Division (EFED) has completed the preliminary problem formulation for the ecological risk, environmental fate, and drinking water assessments to be conducted as part of the registration review of dicamba. This action includes dimethylamine salt (DMA-salt, PC code 029802), diethanolamine salt (DEA-salt, PC code 029803), sodium salt (Na-salt, PC code 029806), diglycoamine salt (DGA-salt, PC code 128931), potassium salt (K-salt, PC code 129043), isopropylamine salt (IPA-salt, PC code 128944) and dicamba acid (dicamba, PC code 029801). Dicamba monoethanolamine salt, triethanolamine salt, methoxybenzoic acid, and aluminum salt were not included in this action as there are no current product registrations for these active ingredients. The problem formulation describes the methods planned to be used during the completion of drinking water and ecological risk assessments in support of registration review and provides an overview of the environmental fate, ecological effects, and potential risks associated with the use of dicamba as well as uncertainties unique to the risk assessment of dicamba. This document also identifies additional studies that would be beneficial to the conduct of an ecological risk assessment. Major findings include:

Data needs for dicamba ecological effects are:

Data on parent dicamba (test guidelines and PC codes in parentheses):

- *Oyster Acute Toxicity Test (shell deposition, OCSPP guideline 850.1025) using TGAI, dicamba acid (029801)*
- *Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)*
- *Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)*
- *Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available*
- *Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species*
- *Seedling Emergence and Seedling Growth (850.4100) using TEP, dicamba acid (029801) on standard suite of 10 terrestrial plant species*
- *Vegetative Vigor (850.4150) using TEP, dicamba acid (029801), DMA-salt (029802), DEA-salt (029803), Na-salt (029806), K-salt (129043) and IPA salt (128944) with 7 terrestrial plant species (onion + 6 dicot species). For DGA-salt (128931), 1 species (lettuce) is required.*
- *Aquatic Plant Toxicity Test Using Lemna spp. (850.4400) using TGAI, dicamba acid (029801)*
- *Tier 1 Adult Honey Bee Acute Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Larval Honey Bee Acute Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Larval Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*

- *Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.*
- *Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies*

In addition, the following effects data is needed for dicamba's major degradate, DCSA:

- *Fish Early-Life Stage Toxicity Test (850.1400) using dicamba's metabolite, DCSA and the same species as used in the test with TGA dicamba.*
- *Daphnid Chronic Toxicity Test (850.1300) using dicamba's metabolite, DCSA.*
- *Avian Reproduction Test (850.2300) using dicamba's metabolite, DCSA and the mallard duck*

Data needs for environmental fate and exposure assessment are:

Data on parent dicamba:

- *Environmental Chemistry Methods and independent laboratory validations for dicamba and DCSA in Soil and Water (850.6100)*
- *Laboratory Volatility (835.1410) for each registered salt and ester formulation intended for use on GMO crops*
- *Field Volatility (835.8100) for each registered salt and ester formulation intended for use on GMO crops.*
- *Spray Droplet Size Spectrum (840.1100) and Spray Drift Field Deposition (835.1200) for each formulation intended for use on GMO crops.*
- *For parent dicamba, additional data on aerobic soil metabolism (835.4100) with US soils.*
- *For parent dicamba, additional data on aerobic aquatic metabolism (835.4300, currently only one study submitted).*

In addition, the following fate data is needed for dicamba's major degradate, DCSA:

- *For the major degradate, dichlorosalicylic acid (DCSA), additional data on aerobic soil metabolism (835.4100).*
- *For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).*

Major uncertainties:

Spray drift was the major route of exposure considered in the risk assessments for dicamba use on GMO cotton and soybeans. Any new formulations for which an Endangered Species Act effect determination must be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300).

Post-application volatilization of dicamba as the acid was a major uncertainty in risk assessments for use on GMO cotton and soybeans. Several formulations of dicamba are intended to reduce volatilization of dicamba in the first few days after application, but the ability of these formulations to delay the formation of the volatile dicamba acid, under a range of environmental conditions, is not well understood. It is also not understood whether off-site movement due to

volatilization is as great as from spray drift at the time of application. Field volatility tests (835.8100) will reduce this uncertainty.

Some GMO crops detoxify dicamba by metabolizing it to 3,6-dichlorosalicylic acid (3,6-DCSA), which is more toxic than parent dicamba to some taxa, including mammals. DCSA is a major degradate under anaerobic aquatic metabolism conditions. Additional chronic toxicity tests using this degradate are required for daphnids, fish and birds.

2. Introduction

Dicamba is a systemic herbicide in the benzoic acid chemical class similar in structure and mode of action to phenoxy herbicides. Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

The use information presented in this problem formulation was obtained from the tables in the EFED Label Data Report dated 6/22/2015, from BEAD's Chemical Profile for Registration Review (USEPA, 2015), and from various evaluated labels. Across the acid and six salts with active registrations, there are a total of 479 end use registrations

Recent labels (*e.g.* the M1691 label, EPA Reg. No. 524-582, containing dicamba DGA salt) contain environmental hazard information regarding the known potential for dicamba to leach into groundwater under certain conditions, such as where soils are permeable or the water table is shallow, but this language does not appear on older labels.

The following labeling statement appears on all dicamba labels to avoid contamination of aquatic environments and drinking water from use on agricultural products.

ENVIRONMENTAL HAZARD STATEMENTS

Keep out of lakes, streams or ponds. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high watermark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on label.

3. Use Characterization

Dicamba is a systemic herbicide in the benzoic acid chemical class similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves. Dicamba was first registered in the United

States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures.

It is registered for use on agricultural crop soils for the following: asparagus, barley, corn, cotton, fallow, grasses grown for seed/forage/fodder/hay, oats, proso/millet, sorghum, soybeans, sugarcane, triticale, wheat, pasture/rangeland and forestry. It is also registered for use on non-agricultural use sites including farm and domestic premises, conservation reserve program land, commercial/industrial lawns, recreational/residential lawns, golf course turf, rights-of-way, fencerows and hedgerows, ornamental herbaceous plants, ornamental woody shrubs and vines, ornamental lawns and turf, ornamental sod (turf), paved areas and paths/patios. On soybean and cotton, it is registered for both pre-emergent use and, on dicamba-tolerant soy and cotton plants only, for post-emergent use as well.

Dicamba is formulated as emulsifiable, soluble concentrate, granular, wetted powder, FIC, and as a solution-ready-to-use. Dicamba can be applied by broadcast spray (aerial and ground), spot treatment, banded, wipe on/wipe off treatment, cut-stem treatments and as a basal bark treatment. The Screening Level Usage Analysis (SLUA) produced by BEAD (**Table 1**, compiled on June 22, 2015) indicates that the greatest uses of dicamba are on corn (1.5 million pounds per year, used on an average of 10% of the crop), pasture and fallow (1.1 million pounds per year) and wheat (500,000 pounds per year used on an average of 10% of the crop).

Table 1. Screening Level Estimates of Agricultural Uses of Dicamba (PC codes: 029801, 029802, 029803, 029806, 128931, 129043, and 128944). Based on reporting years from 2004—2013.

	Crop	Annual Average	Percent Crop Treated	
		Lbs. A.I.	Average	Maximum
1	Alfalfa+	2,000	<1	<2.5
2	Asparagus	<500	5	10
3	Barley	20,000	5	10
4	Canola+	2,000	<2.5	10
5	Corn	1,500,000	10	15
6	Cotton	200,000	5	15
7	Dry Beans/Peas+	3,000	<2.5	<2.5
8	Fallow	500,000	15	35
9	Oats	6,000	<2.5	<2.5
10	Pasture	600,000	<2.5	5
11	Peanuts+	1,000	<1	<2.5
12	Pecans+	1,000	<2.5	<2.5
13	Rice	3,000	<1	<2.5
14	Sorghum	200,000	15	25
15	Soybeans	100,000	<2.5	<2.5
16	Squash+	<500	<2.5	<2.5
17	Sugarcane	40,000	20	25

18	Sunflowers+	9,000	5	10
19	Sweet Corn	<500	<1	<2.5
20	Wheat	500,000	10	25

A number of labels for use in agricultural fallow/conservation reserve land, barley, cotton, forestry, pastures, rangeland, ornamental turf and soybeans do not specify the maximum number of applications per year. Without clarification of the labels or details on usage in these use sites, conservative assumptions will be made.

The tables in **Appendix A** summarize use patterns for dicamba acid (PC code 029801; MW: 221.0 g/mol), the DMA-salt of dicamba (PC code 029802; MW: 226.1 g/mol), the DEA-salt of dicamba (PC code 029803; MW: 326.18), the Na-salt of dicamba (PC code 029806; MW 243.0 g/mol), the DGA-salt of dicamba (PC code 128931; MW: 326.18), the IPA-salt of dicamba (PC code 128944, MW: 280.04 and the K-salt of dicamba (PC code 129043; MW: 259.1 g/mol). Though these are distinct chemical moieties, they will be assessed together using the acid equivalence (a.e.) method. That is, only the dicamba acid component will be assessed and the application rates of the DMA-salt, the DEA-salt, the Na-salt, the DGA-salt, the IPA-salt and the K-salt will be adjusted to account for only dicamba acid.

4. Conclusions from Previous Risk Assessments

4.1. Ecological Risk Assessment

The most recent ecological risk assessments conducted on dicamba or its associated salts were the 2016 risk assessment for the use of dicamba DGA salt on dicamba-tolerant (DT-) cotton (USEPA, 2016a; D404823), an addendum to the use of dicamba DGA salt on dicamba-tolerant (DT-) soybean (USEPA, 2016b; D426789) and refined endangered species assessments for 34 states (USEPA, 2016c-e; D416416+, D422305, D425049) for the use of DGA salt on dicamba-tolerant soybeans and cotton. The Tier I risk assessment on DT-cotton and the addendum on DT-soybean identified that potential direct risk concerns could not be excluded for mammals (chronic, due to residues of dicamba's metabolite, DCSA in DT-soybean), birds (acute for both uses from parent dicamba, chronic in soybean only, due to DCSA residues in DT-soybeans) and terrestrial plants (both uses, from parent dicamba). Residues of DCSA in DT-soybean plant tissues were found to be higher than residues of parent dicamba and persisted longer. These documents also addressed concerns regarding the potential for dicamba to move off-site through spray drift, volatility and run-off and specified an in-field buffer (designed to keep dicamba residue concentrations above which could cause adverse effects restricted to the field) specific to the tested DGA-salt formulation (M1691, EPA Reg No. 524-582) with specific nozzle requirements intended to restrict the droplet spectra to ultra-coarse and extremely coarse sized droplets.

EFED completed the reregistration chapter for dicamba/dicamba salts in 2005 (USEPA, 2005). The RED assessment determined that bridging data indicate that dicamba salts will rapidly convert to the free acid of dicamba and that the submitted ecological effects data generally

indicate similar toxicity of the acid and salts (based on acid equivalents). Therefore, EFED concluded that environmental fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. However, the EFED RED chapter also identified data gaps for seedling emergence and vegetative vigor studies for dicamba acid and all salts, using typical end-use products (TEP) and requested these studies for the 5 most sensitive species in available plant tests with technical grade active ingredient (TGAI) dicamba acid (soybean, onion, turnip, tomato and lettuce). Seedling emergence and vegetative vigor data were subsequently submitted and determined to be acceptable for dicamba DGA salt, but not for any of the other salts or for a dicamba acid TEP.

4.2. *Drinking Water Exposure Assessments*

A comprehensive drinking water assessment was performed for dicamba at the time of the RED in 2005. Later assessments for new uses on sweet corn and sugarcane were done in 2005 and 2007.

A new drinking water assessment will be performed for Registration Review, because both the models and guidance for such assessments has changed considerably since 2005. This will include a new ground water assessment with PRZM-GW, as part of the Pesticides Water Calculator (PWC).

The new assessment will address the degradate DCSA (dichlorosalicylic acid), which is formed in greater amounts by crops engineered to be resistant to dicamba.

4.3. *Clean Water Act Programs*

Dicamba is not identified as a cause of impairment for any water bodies listed as impaired under section 303(d) of the Clean Water Act. No Total Maximum Daily Load (TMDL) criteria have been developed for dicamba. Aquatic benchmarks have been established for dicamba acid and its dimethylamine (DMA) and sodium salts and are available at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-pesticide-registration>. Any data submitted or otherwise located as part of the registration review process may be used to update aquatic life benchmarks if applicable.

5. Environmental Fate and Transport

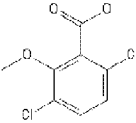
Dicamba as the acid is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs ($pK_a = 1.9$). Dicamba is not stable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization. It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target

plant injury.¹ Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major routes of exposure to non-target organisms is likely spray drift, runoff and volatilization. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in **Table 2**. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the cited documents (USEPA, 2005 and USEPA, 2011). Physical properties of dicamba acid are given in **Table 3**. Aquatic modeling input parameters are given for dicamba acid in **Table 4** and for 3,6-DCSA in **Table 5**.

Table 2. Chemical Structures Relevant to this Assessment

<p>Dicamba acid <chem>COc1c(Cl)ccc(Cl)c1C(=O)O</chem></p>	
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¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

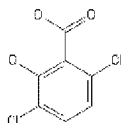
3,6-dichlorosalicylic acid (DCSA)	
<chem>C1(=C(C(=CC=C1Cl)Cl)O)C(=O)O</chem>	

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))
Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZ Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)

Vapor Pressure	3.41 E-05 torr (25°C) SANDOZ Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

TABLE 4. Fate Data for Dicamba.

Model Input Variable	Input Value	Source and Comments
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. Fate Data for Dicamba's Metabolite, DCSA.

Model Input Variable	Input Value	Source and Comments
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

6. Receptors

Tables 6 through 16 provide a summary of the aquatic and terrestrial taxonomic groups, and the most sensitive surrogate species tested to characterize the potential acute and chronic ecological effects of dicamba and its associated salts. In addition, the tables provide a preliminary overview of the potential acute toxicity of dicamba and its associated salts by providing the acute toxicity classifications. In the following tables, the toxicity endpoint values for all the salts have been converted to dicamba acid equivalents to facilitate comparison between the different forms and these values will be used in the risk assessment.

6.1. *Effects to Aquatic Organisms*

Tables 6-11 show the most sensitive available aquatic toxicological data for dicamba acid and its associated salts adjusted to acid equivalents. No aquatic ecotoxicity data are available for the diethanolamine salt (PC code 029803). Based on the available ecotoxicity information, dicamba and its associated salts are practically non-toxic to slightly toxic on an acute basis to estuarine/marine and freshwater fish (dicamba acid appearing to be the most toxic) and generally practically non-toxic to freshwater and estuarine/marine invertebrates, except for one TEP study with dicamba Na-salt (MRID 00085935) that indicated this formulation was moderately toxic on an acute basis to freshwater invertebrates (48-hr EC₅₀ of 9.2 mg a.e./L. Given that dicamba salts should disassociate to the acid rapidly in water, and the evident lack of toxicity observed in all the other available freshwater invertebrate studies, it is likely that the observed toxicity in this study is due to effects from the formulation, rather than toxicity specific to the sodium salt. However, this value could potentially be used qualitatively as a conservative estimate of toxicity across dicamba acid and other salts in the risk assessment. No acute data are available for assessing the toxicity of dicamba or its associated salts to estuarine/marine mollusks and no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this uncertainty. For aquatic plants, dicamba appears to be more toxic to non-vascular plants than to vascular plants, however there is some uncertainty to this as the available study with duckweed (MRID 42774111) was initiated with highly acidic

conditions (pH 4.9-5.0) which may have impacted control performance and masked any treatment-related effects. Therefore, a new study with duckweed is requested at this time.

No acute or chronic aquatic toxicological data is available for dicamba's metabolite, DCSA, though the EU's footprint database² reports similar acute toxicity of DCSA to parent dicamba and significantly lower toxicity of DCSA to aquatic plants. Ecosar v1.1, a model predicting toxicity based on a chemical's molecular structure predicts DCSA to be both at least 30 times more toxic on a chronic basis than parent dicamba to fish and several orders of magnitude more toxic than parent dicamba to freshwater invertebrates using the neutral organic chemical class for comparison. The uncertainty in using the neutral organic Ecosar class for the acids, dicamba and DCSA, is acknowledged. Additionally, as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA. Given the known increased chronic toxicity of the degradate to mammals compared to parent dicamba and the model's predicted chronic toxicity differential to fish and invertebrates based on the chemical structures of the parent and degradate, the lack of chronic data for fish and invertebrates potentially exposed to the major metabolite DCSA is considered a major data gap.

Table 6. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for Dicamba acid (PC Code 029801)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source/Classification
Freshwater fish ¹	Acute	TGAI 88%	Rainbow trout (<i>Oncorhynchus mykiss</i>)	96-hr LC ₅₀ = 28 mg a.e./L Nominal	Slightly toxic	MRID 40098001/ Supplemental — Quantitative
	Chronic (Early Life-Stage)	--	No Data	N/A	N/A	N/A
Freshwater invertebrates	Acute	TGAI 88%	Water Flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ > 100 mg a.e./L Nominal	Practically non-toxic	MRID 40098001/ Supplemental — Quantitative
	Chronic	--	No Data	No Data	N/A	N/A
Estuarine/marine fish	Acute	TGAI 86.8%	Sheepshead minnow (<i>Cyprinodon variegates</i>)	96-hr LC ₅₀ > 180 mg a.e./L Nominal	Practically non-toxic	MRID 00025390/ Acceptable
	Chronic	--	No Data	N/A	N/A	N/A

² Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>). This database reports acute fish and freshwater invertebrate endpoints of > 100 mg/L and 89 mg/L, respectively and aquatic plant EC₅₀s of >73 mg/L and 138 mg/L for vascular and non-vascular aquatic plants.

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source/Classification
Estuarine/marine invertebrates	Acute	TGAI 86.8%	Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	Practically non-toxic	MRID 00034702/ Acceptable
	Chronic	--	No Data	N/A	N/A	N/A
	Acute	--	No Data	No Data	N/A	--
Aquatic plants and algae	Vascular	--	No Data	N/A	N/A	--
	Non-vascular	TGAI 89.5%	Marine Diatom (<i>Skeletonema costatum</i>)	120-Hr EC ₅₀ = 0.493 mg ae/L (0.09—4.1) NOAEC = 0.011 mg ae/L Mean-measured	N/A	MRID 42774110/ Acceptable

¹ Freshwater fish are surrogates for aquatic-phase amphibians.

Table 7. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for Dicamba dimethylamine salt (PC Code 029802)

Taxonomic Group	Study Type	TGAI/TEP % Dicamba ae	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 11.5%	Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i>	96-Hr LC ₅₀ > 112.4 mg ae/L	Practically non-toxic	MRIDs 00046183 00046184/ Acceptable
Freshwater invertebrates	Acute	TEP 48.2%	Water Flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ = 1563 mg a.e./L (1270—1856)	Practically non-toxic	MRID 00028283/ Acceptable

Table 8. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba sodium salt (PC Code 029806)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 22%	Rainbow Trout (<i>Oncorhynchus mykiss</i>)	96-Hr LC ₅₀ = 111.6 mg ae/L (436.3—589.9) Nominal	Practically non-toxic	MRID 00029623/ Acceptable
Freshwater invertebrates	Acute	TEP 26.5%	Water flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ = 9.2 mg ae/L	Moderately toxic	MRID 00085935 Acceptable

Table 9. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba DGA salt (PC Code 128931)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 40.2%	Rainbow Trout (<i>Oncorhynchus mykiss</i>) & Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ > 270.8 mg ae/L Nominal	Practically non-toxic	MRIDs 00162068 00162067/ Acceptable
Freshwater invertebrates	Acute	TEP 40.2%	Water flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ > 270.8 mg ae/L	Practically non-toxic	MRID 00162069/ Supplemental — Quantitative

Table 10. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba K salt (PC Code 129043)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source (Classification)
Freshwater fish	Acute	TEP 38%	Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ = 73.2 mg ae/L Nominal	Practically non-toxic	ACCN 00258932/ Supplemental — Qualitative
Freshwater invertebrates	Acute	TEP 40.2%	Water flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ = 301 mg ae/L Nominal	Practically non-toxic	ACCN 00258983/ Supplemental — Qualitative

Table 11. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba IPA salt (PC Code 128944)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source (Classification)
Freshwater fish	Acute	TEP 32.5%	Rainbow trout (<i>Oncorhynchus mykiss</i>) & Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ > 256 mg a.e./L Nominal	Practically non-toxic	MRIDs 00265440 00265441/ Acceptable
Freshwater invertebrates	Acute	TEP 32.5%	Water flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ > 256 mg a.e./L Nominal	Practically non-toxic	MRID 00265442/ Supplemental — Quantitative

6.2. *Effects to Terrestrial Organisms*

Tables 12-17 show the most sensitive available terrestrial toxicological data for dicamba acid and its associated salts. No terrestrial ecotoxicity data are available for the DEA-salt (PC code 029803) or the IPA-salt (PC code 128944. On an acute oral basis to birds, the toxicity of dicamba and its associated salts ranges from practically non-toxic to moderately toxic, with dicamba acid having the most sensitive endpoint. No acute oral data is available for dicamba's toxicity to passerine birds, which have the potential to be more sensitive than the tested surrogate species (bobwhite quail). On an acute dietary basis to birds, treatment-related effects and mortalities were generally not observed even at the highest tested doses, leading to non-definitive (*i.e.* greater than) LC₅₀s and sub-acute toxicity classifications of practically non-toxic to slightly toxic. The only sensitive chronic avian endpoint was for mallard ducks (21-week NOAEC of 695 mg a.e./kg-diet.) based on moderate (11-21%) inhibitions in the number of hatchlings, 14-day old chicks and 14-day old chicks as a percentage of eggs laid in the 1390 mg a.i./kg-diet treatment group compared to the control group. However, these reductions were not statistically significant and potentially could be due to natural variability. Therefore, it is possible that this endpoint may overestimate the chronic toxicity of dicamba to avian species.

Dicamba is practically non-toxic to mammals on acute oral basis. Chronic effects observed in the 2-generation rat study were based on neurotoxicity, delayed maturation of the F₀ generation, and decreased pup weight in both the F₁ and F₂ generations at 450 mg a.e./kg-diet. Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees. This is considered a major data gap.

For terrestrial plants, no acceptable data are available for TEPs with dicamba acid or any of its associated salts, with the exception of the DGA-salt. A seedling emergence and vegetative vigor study with dicamba acid (MRID 42846301), is considered supplemental due to the use of TGAI instead of TEP and since the test plants were cultivated in support media of pure sand with 0.11-0.17% organic matter rather than soil and is not representative of more typical conditions that plants exposed to dicamba may face. Though the plants in the study were bottom-watered, there is nonetheless concern that some dicamba may have leached downward in the sand, resulting in uncertainty as to the actual exposures the plants received. Therefore, new vegetative vigor data is needed for representative TEPs of each salt (other than the DGA salt) and dicamba acid as well as seedling emergence data for dicamba acid. For dicamba DGA salt, the submitted seedling emergence and vegetative vigor studies were acceptable (MRIDs 47815101 and 47815102), but new vegetative vigor data are needed for lettuce only, due to poor performance of lettuce control plants in the available vegetative vigor study.

Table 18 shows the available terrestrial toxicological data for dicamba's metabolite, DCSA. Mammalian data indicate that DCSA has similar acute toxicity as parent dicamba, but is significantly more toxic on a chronic basis with statistically significant inhibitions (6-9%) in 14-21 post-natal days pup weight at the 37 mg/kg/d treatment group, relative to controls, and a corresponding NOAEL of 4 mg/kg/d based on male pre-mating doses. A recent benchmark dose analysis conducted by HED (USEPA, 2016f) determined benchmark doses based on both male pre-mating doses and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup

body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. In the risk assessment, EPA will use the 8 mg/kg/d NOAEL based on dam lactation doses as the chronic mammalian endpoint.

No chronic data are available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). In the absence of additional data, as a conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch. However, chronic avian reproduction data with DCSA would decrease the uncertainty associated with this approach.

Table 12. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba acid (PC Code 029801)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds ¹	Acute oral	86.9%	Bobwhite quail (<i>Colinus virginianus</i>)	LD ₅₀ = 188 mg a.e./kg-bw (141—250) Slope = 6.0 (2.6—9.3)	Moderately toxic	MRIDs 42918001 42774105 (Acceptable)
	Acute oral (passerine)	--	No Data	No Data	N/A	--
	Sub-acute dietary	86.8%	Bobwhite quail (<i>Colinus virginianus</i>)	8-D LC ₅₀ > 8,680 ppm a.e.	Practically non-toxic	MRID 00025391 (Acceptable)
	Chronic	86.9	Mallard duck (<i>Anas platyrhynchos</i>)	NOAEC = 695 ppm a.e. LOAEC = 1390 ppm a.e. Reduced Hatch, and Chick Survival	N/A	MRID 43814003 (Acceptable)
Mammals	Acute Oral	TGAI 99.7%	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg/kg (males) (2010-3740)	Practically non-toxic	MRID 00078444 (Acceptable)
	Acute Inhalation	TEP	Laboratory rat (<i>Rattus norvegicus</i>)	4-Hr LC ₅₀ > 5.3 mg a.e./L	IV	MRID 00263861 (Acceptable)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Subchronic Feeding	TGAI 86.8%	Laboratory rat (<i>Rattus norvegicus</i>)	13-Wk NOEL: 500 mg/kg/d LOEL: 1000 mg/kg/day Endpoints: body wt. changes, liver effects	N/A	MRID 00128093 (Acceptable)
	Chronic (2-Generation Reproduction)	TGAI 86.9%	Laboratory rat (<i>Rattus norvegicus</i>)	NOAEL = 136 mg ae/kg-diet/day LOAEL = 450 mg a.e./kg-diet/day Endpoints: neurotoxicity, delayed maturation of F0 gen, decreased pup weight	N/A	MRID 43137101 (Acceptable)
Terrestrial Invertebrates	Acute contact (adult)	TEP % ai unknown	Honey bee (<i>Apis mellifera</i> L.)	48-hr LD ₅₀ > 90.65 µg/bee	Practically non-toxic	MRID 00036935 (Supplemental —Quantitative)
	Acute oral (adult)	--	No Data	No Data	N/A	--
	Chronic oral (adult)	--	No Data	No Data	N/A	--
	Acute larval	--	No Data	No Data	N/A	--
	Chronic larval	--	No Data	No Data	N/A	--
Terrestrial plants	Seedling Emergence	--	No Data	No Data	N/A	MRID 42846301 (Supplemental —Qualitative)
		--	No Data	No Data	N/A	MRID 42846301 (Supplemental —Qualitative)
	Vegetative Vigor	--	Monocot – No Data	No Data	N/A	--
		--	Dicot – No Data	No Data	N/A	--

¹ Birds are considered a surrogate for terrestrial phase amphibians and reptiles

Table 13. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba DMA-salt (PC Code 029802)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	TEP 11.5%	Mallard Duck <i>Anas platyrhynchos</i>	14-D LD ₅₀ > 282 a.e./kg-bw	Practically non-toxic	MRIDs 00046180 (Acceptable)
	Sub-acute dietary	TEP 48.2%	Bobwhite quail <i>Colinus virginianus</i> & Mallard Duck <i>Anas platyrhynchos</i>	8-D LC ₅₀ > 2,185 ppm a.e.	Practically non-toxic	MRIDs 00034693 00022527 (Acceptable)

Table 14. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba Na-salt (PC Code 029806)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Sub-acute dietary	TEP 26.5%	Bobwhite quail <i>Colinus virginianus</i>	8-D LC ₅₀ > 2,409 ppm a.e.	Slightly toxic	MRID 00068785 (Acceptable)

Table 15. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba DGA-salt (PC Code 128931)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	No Data ¹	--	N/A	No Data	No Data

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Sub-acute dietary	TEP 40%	Bobwhite quail <i>Colinus virginianus</i> & Mallard Duck <i>Anas platyrhynchos</i>	8-D LC ₅₀ > 609 ppm a.e.	Slightly Toxic	MRIDs 00162071 00162072 (Acceptable)
Terrestrial plants	Seedling Emergence	TEP 40.3%	Monocot – Onion (<i>Allium cepa</i>)	EC ₂₅ = 1.68 lb ae/A NOAEC = 0.64 lb ae/A	N/A	MRID 47815101 (Acceptable)
		TEP 40.3%	Dicot – Soybean (<i>Glycine max</i>)	EC ₂₅ = 0.170 lb ae/A NOAEC = 0.0702 lbs ae/A	N/A	
	Vegetative Vigor	TEP 40.3%	Monocot – Onion (<i>Allium cepa</i>)	EC ₂₅ = 0.472 lbs ae/A EC ₀₅ = 0.137 lbs ae/A	N/A	MRID 47815101 (Acceptable)
		TEP 40.3%	Dicot – Soybean (<i>Glycine max</i>)	EC ₂₅ = 0.000513 lb ae/A NOAEC = 0.000261 lb ae/A	N/A	

¹ Previously, a study with the bobwhite quail (MRID 00162070) was deemed to be acceptable with an LD₅₀ of 387.2 ppm a.e. However, regurgitation occurred at several doses, including the lowest dose (117 ppm a.e.). The regurgitation did not follow a dose response, and this study has been downgraded to invalid.

Table 16. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba K-salt (PC Code 129043)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	TEP 38%	Bobwhite quail (<i>Colinus virginianus</i>)	14-D LD ₅₀ = 235 mg a.e./kg-bw	Moderately toxic	MRID 00261466 (1986) Supplemental-- Quantitative

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Sub-acute dietary	TEP 38%	Bobwhite quail (<i>Colinus virginianus</i>) & Mallard duck (<i>Anas platyrhynchos</i>)	8-D LC ₅₀ > 1,822 ppm a.e.	Slightly toxic	MRIDs 00261465 00261466 (Supplemental--Quantitative)

Table 17. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba's Metabolite, DCSA.

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Mammals	Acute Oral	TGAI 99.7%	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 mg/kg (males)	Practically non-toxic	MRID 47899504 (Acceptable)
	Chronic (2-Generation Reproduction)	TGAI 86.9%	Laboratory rat (<i>Rattus norvegicus</i>)	NOAEL = 8 mg ac/kg-diet/day LOAEL = 78 mg a.e./kg-diet/day, using female lactation doses Endpoints: decreased pup weight	N/A	MRID 47899517 (Acceptable)

6.3. Ecological Incidents

A preliminary review on May 17, 2016 of the Ecological Incident Information System (EIIS, version 2.1.1), which is maintained by the Agency's Office of Pesticide Programs and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 178 reported ecological incidents in the United States associated with the use of the dicamba acid and salt active ingredients (summarized by certainty in **Table 18**). This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents

classified as ‘unlikely’ the result of or ‘unrelated’ to dicamba will not be included in this Problem Formulation or the ecological risk assessment conducted for Registration Review.

All of the dicamba incidents in these databases, excluding those classified as ‘unlikely’ or ‘unrelated’, occurred between 1991 and 2013. Six (3%) of the dicamba incidents involved aquatic animals, one (<1%) involved terrestrial animals and 171 (96%) involved plants. The certainty categories regarding the likelihood that the use of dicamba caused the 178 incidents ranged from unlikely (9 incidents), possible (104 incidents), probable (69 incidents) to highly probable (5 incidents). 53 of the incidents were considered registered uses at the time of the incident, 43 involved misuses, and the legality of the use was undetermined in 82 incidents.

EPA is also aware of additional recent incident information (2012—2015), that has not yet been included in EIIS, relating to the use of dicamba on dicamba-tolerant soybean and cotton crops. Information relating to the current knowledge and understanding surrounding these incidents is described in the Section 3 New Use assessment for dicamba on dicamba-tolerant cotton (D404823; USEPA, 2016a) and the addendum to Section 3 New Use assessment for dicamba on dicamba-tolerant soybean (D426789, USEPA, 2016b)

Table 18. Incidents found in the Ecological Incident Information System across all salts and dicamba acid

Incident Type	Use Type	Certainty				
		All (excluding unlikely)	Unlikely	Possible	Probable	Highly Probable
Fish	Misuse	0	0	0	0	0
	Registered Use	1	0	1	0	0
	Undetermined	5	1	5	0	0
Wildlife	Misuse	0	0	0	0	0
	Registered Use	0	0	0	0	0
	Undetermined	1	2	1	0	0
Plants	Misuse	43	1	18	21	4
	Registered Use	52	2	19	33	0
	Undetermined	76	3	60	15	1
Total		178	9	104	69	5

In addition to the incidents recorded in EIIS and AIMS, additional incidents have been reported to the Agency in aggregated incident reports. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as ‘minor fish and wildlife’ (W-B), ‘minor plant’ (P-B), and ‘other non-target’ (ONT) incidents. ‘Other non-target’

incidents include reports of adverse effects to insects and other terrestrial invertebrates. For dicamba, registrants have reported 24 minor fish and wildlife incidents, 8340 minor plant incidents, and 3 other non-target incidents. Unless additional information on these aggregated incidents become available, they will be assumed to be representative of registered uses of dicamba in the risk assessment.

7. Exposure Pathways of Concern

The environmental fate properties and use patterns of dicamba indicate that direct spray onto food residues, spray drift, leaching to ground water, volatilization, and runoff represent potential transport mechanisms of dicamba to aquatic and terrestrial organisms.

Drinking water and inhalation exposure pathways were screened using the SIP (Screening Imbibition Program) and STIR (Screening Tool for Inhalation Risk) screening methods. Drinking water with dicamba or DCSA residues was found to be a potential exposure pathway of concern (LOC exceedances are expected) on an acute and chronic basis for birds and mammals. SIP and STIR are described in detail at:
<http://www.epa.gov/oppefed1/models/terrestrial/index.htm>.

The Screening Tool for Inhalation Risk (STIR v.1.0) was used to assess the potential for risk to birds and mammals through inhalation exposure. The exposure pathways that are assessed by this tool include both droplet inhalation and vapor-phase inhalation. STIR, used in the problem formulation phase, is intended to determine if exposure is likely and not whether the potential for risk exists based on a chemical's maximum application rate, molecular weight and vapor pressure and the available mammalian acute oral and inhalation toxicity endpoints and avian acute oral endpoint (an adjusted avian inhalation toxicity endpoint is estimated from the mammalian toxicity data). If STIR predicts that exposure is likely, additional inhalation data may be necessary to adequately assess risk due to the inhalation exposure pathway. Based on STIR screening analysis, inhalation is not considered likely to be a significant route of exposure for birds and mammals from vapor exposure, but for birds could potentially be a significant route of exposure where applications are greater than 2.1 lbs a.e./A. However, this concern is based on the assumption that the highest test concentration from the available mammalian inhalation toxicity test (5.3 mg/L) results in 50% mortality, but as this is a non-definitive (>) endpoint, it is likely highly conservative. Given that few maximum dicamba application rates are greater than 2.1 lbs a.e./A, and the mammalian inhalation endpoint was non-definitive and therefore is likely highly conservative, no additional inhalation data is requested. See **Appendix B** for STIR inputs and outputs.

The Screening Imbibition Program (SIP 1.0, Released June 15, 2010) was used to calculate an upper bound estimate of exposure using dicamba's and DCSA's solubility in water (6100 mg/L for dicamba, 2112 mg/L for DCSA), the most sensitive acute and chronic avian toxicity endpoints (bobwhite acute LD₅₀ of 188 mg/kg-bw, mallard NOAEC of 695 mg/kg-diet) and the most sensitive acute and chronic mammalian toxicity endpoints (male laboratory rat acute LD₅₀ of 2740 mg/kg-bw and rat chronic NOAEL of 136 mg/kg-bw for dicamba, acute and chronic rat endpoints of 2641 mg/kg-bw and 8 mg/kg-bw for DCSA). Drinking water exposure alone to either dicamba or DCSA residues was determined to be a potential pathway of concern for

mammalian and avian species on both an acute and chronic basis. This pathway will be explored further with the development of SIP v.2.0 in the Ecological Risk Assessment for dicamba. The chronic avian data for DCSA expected to be requested in the DCI will also be used in this assessment of drinking water exposure. For a sample of the output generated by SIP v.1.0, please see **Appendix B**. Detailed information about the SIP v.1.0, as well as the tool, can be found on the EPA's website at http://www.epa.gov/pesticides/science/models_pg.htm#terrestrial.

8. Analysis Plan

8.1. Stressors of Concern

8.1.1. Ecological Risk Assessment

The stressors of concern are parent dicamba (as the acid, salts and esters) and the degradate 3,6-DCSA (dichlorosalicylic acid).

8.1.2. Drinking Water – Human Health

The drinking water assessments conducted to support the registration review human health risk assessments of dicamba will address the parent compound only as acid equivalents across the various formulations, in surface and ground waters. The degradate, 3,6-DCSA will be assessed separately.

8.2. Measures of Exposure

EFED will use standard available models to evaluate potential exposures to aquatic and terrestrial organisms as described at http://www.epa.gov/pesticides/science/models_db.htm.

Available Monitoring Data

The USGS Water Quality Portal (<http://waterqualitydata.us/portal/>) was queried on 05/18/16 for monitoring data using the search term “dicamba.” 50,458 records were returned for water and sediment analyses primarily from the STORET and NWIS databases. The vast majority of these records appeared to be “non-detect” or “below reporting limit” for dicamba, as expected. An analysis of these data will be done in the risk assessment.

Aquatic Exposure Modeling

The models used to predict aquatic estimated environmental concentrations (EECs) is the Pesticides in Water Calculator (PWC) which incorporates PRZM and the Variable Volume Water Model (VVWM) for surface water and PRZM-GW for ground water. These are publicly available at: <http://www.epa.gov/oppefed1/models/water/index.htm>. Modeling will be conducted using the acid equivalent approach, plus a Total Toxic Residue including 3,6-DCSA if needed.

Terrestrial Exposure Modeling

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX model (version 1.5.2, March 2012). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenaga 1972). The Fletcher *et al.* (1994) modifications to the Kenaga nomograph are based on measured field residues from 249 published research papers, including information on 118 species of plants, 121 pesticides, and 17 chemical classes.

In recent risk assessments (USEPA, 2016a-b), EFED has used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value of **8.4 days**, which will be used in the registration review risk assessment.

Screening level calculations have suggested that the drinking water exposure pathway may be a significant concern for birds and mammals and will be further evaluated at the time of risk assessment with SIP v2.0.

EECs for terrestrial plants inhabiting dry and wetland areas are derived using TerrPlant (version 1.2.2, December 2006). This model uses estimates of pesticides in runoff and in spray drift to calculate EECs. EECs are based upon solubility, application rate and minimum incorporation depth in addition to type of formulation and method of application. The Agency is currently developing a replacement model for TerrPlant. If the replacement has been approved prior to the initiation of the risk assessment, this new model will be used instead.

Two spray drift models, AgDisp and AgDRIFT, are used to assess exposures of aquatic and terrestrial organisms to dicamba deposited in terrestrial and aquatic habitats by spray drift. AgDRIFT (version 2.1.1; dated 12/29/2011) is the model most commonly used to simulate spray drift into terrestrial and aquatic environments from aerial and ground applications. AgDisp (version 8.13; dated 12/14/2004) (Teske and Curbishley, 2003) is used when a parameter needs to be modeled that is not available in AgDRIFT. Spray drift analysis will be an important part of the analysis in defining the potential area of effects to non-target species.

8.3. Measures of Effect

Toxicity data presented in Section 6 of this problem formulation will be used to calculate risk quotients. Any additional information submitted by the registrant or found in the open literature prior to conduct of the risk assessment will also be considered. The open literature studies are identified using EPA's ECOTOXicology database (ECOTOX) (USEPA, 2009), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of both sources of data can also provide insight into the direct and indirect effects of pesticides on biotic communities from loss of species that are sensitive to the chemicals and from changes in structure and functional characteristics of the affected communities.

9. Endangered Species Assessments

Consistent with the Agency's responsibility under the Endangered Species Act (ESA), the Agency will evaluate risks to federally listed threatened and/or endangered (listed) species from registered uses of pesticides in registration review. The process for evaluating potential risks to listed species is further described at <https://www.epa.gov/endangered-species>. Three endangered species assessments were recently conducted for the post-emergent use of dicamba DGA salt on dicamba-tolerant soybean and cotton (USEPA, 2016c-e. D416416+, D422305, D425049) covering listed species in 34 states.

10. Endocrine Disruptor Screening Program

As required by FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of the Preliminary Problem Formulation for Registration Review (DP Barcode 426710), EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), dicamba is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2

testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013^[1] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. Dicamba is not on either the first or second list. For further information on the status of the EDSP, the policies and procedures, the initial list of 67 chemicals or the overview of the second list of 109 chemicals, the test guidelines and the Tier 1 screening battery, please visit our website: <http://www.epa.gov/endo/>.

11. Preliminary Identification of Data Gaps

11.1. Environmental Fate

Table 19 identifies environmental fate studies by MRID that offer data for each guideline requirement, as well as study classifications and whether or not further data are needed in order to support risk assessment.

Table 19. Submitted Environmental Fate Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Comments, Justification and Assumptions EPA will Make in Absence of Data
835.2120	Hydrolysis	40547902 40335501 43245208	Acceptable	No	
835.2240	Aqueous photolysis	42774102	Acceptable	No	
835.2410	Soil photolysis	42774103	Acceptable	No	
835.4100	Aerobic Soil Metabolism	43245207 49067702 48718002	Acceptable Supplemental Supplemental	Yes	(One US soil) (Two European soils) (Four US soils) Acceptable data on more than one US soil is requested
835.4200	Anaerobic soil metabolism	40547906 43245208	Acceptable	No	
835.4300	Aerobic aquatic metabolism	43758509	Supplemental	Yes	Acceptable data on more than one system is requested.
835.4400	Anaerobic aquatic metabolism	43245208	Acceptable	No	

^[1] See <http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074> for the final second list of chemicals.

OCSPP Guideline	Data Requirement	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Comments, Justification and Assumptions EPA will Make in Absence of Data
835.1230 835.1240	Adsorption/ desorption and leaching	42774101 43095301 (DCSA)	Acceptable Supplemental	No	
835.6100	Terrestrial field dissipation	40547908 42754101 42754102 42754103 44373708 48718005 43361506 43361507 43651405 43651407 43651408	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental	No	K salt K salt Na and DGA salts DGA salt DMA salt DGA salt Na salt
835.1410	Laboratory Volatility	41966602	Acceptable	Yes	Study is for dicamba K salt. Data on all formulations proposed for use on dicamba-tolerant crops required.
835.8100	Field Volatility	49022501 49067704	Supplemental Pending	Yes	Requested for each registered salt and ester formulation intended for use on dicamba-tolerant crops.
840.1100	Spray Drift Droplet Spectrum	49671601 49671602 49067704	Pending	Yes	Requested for each formulation intended for use on dicamba-tolerant crops.
840.1200	Spray Drift Field Deposition	49770301	Pending	Yes	Requested for each formulation intended for use on dicamba-tolerant crops.
850.1730	Fish BCF	--	Waived	No	Bioconcentration in fish is not expected based on dicamba's solubility and pKa.
850.6100	Water and Soil Environmental Chemistry Methods			Yes	
850.6100	Soil and Water Independent Laboratory Validation			Yes	
835.6100	Foliar dissipation			Yes	Data are needed for parent dicamba and for DCSA

11.2. Effects

Table 20 and **Table 21** identify ecological effects studies by MRID that offer data for each guideline requirement, as well as study classifications and whether or not further data are needed in order to support risk assessment.

Table 20. Submitted Aquatic Ecological Effects Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Current Additional Data Need
850.1010	Freshwater invertebrate acute toxicity	029801	40098001	Supplemental-- Quantitative	No	--
		029802	00028283	Acceptable	No	
		029806	00085935	Acceptable	No	
		128931	00162069	Supplemental— Quantitative	No	
		128944	00265442	Supplemental-- Quantitative	No	
		129043	00258983	Supplemental— Qualitative	No	
850.1025 850.1035 850.1045 850.1055	Saltwater invertebrate acute toxicity	029801	00034702	Acceptable	No	No data are available for dicamba's toxicity to estuarine/marine mollusks. Data following the 850.1025 (shell deposition) guideline should be submitted using TGAi dicamba acid.
		029801	No Data	N/A	Yes	
850.1075	Freshwater fish acute toxicity	029801	40098001	Supplemental-- Quantitative	No	--
		029802	00263000 00046183 00046184	Acceptable	No	
		029806	00029623	Acceptable	No	
		128931	00162068 00162067	Acceptable	No	
		128944	00265440 00265441	Acceptable	No	
		129043	Acc# 00258932	Supplemental— Quantitative	No	
850.1075	Saltwater fish acute toxicity	029801	00025390	Acceptable	No	--
850.1300	Freshwater invertebrate life cycle	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to freshwater invertebrates. A freshwater invertebrate life cycle study should be submitted using a species for which acute data is available using TGAi dicamba acid. Additionally, due to empirical mammalian data and predicted chronic toxicity to aquatic invertebrates, chronic daphnid data should be submitted for DCSA.
		Metabolite DCSA	No Data	N/A	Yes	

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Current Additional Data Need
850.1350	Saltwater invertebrates life cycle	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to saltwater invertebrates. A saltwater invertebrate life cycle study should be submitted using a species for which acute data is available using TGAI dicamba acid.
850.1400	Freshwater fish early-life stage	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to freshwater fish. A freshwater fish early life stage study should be submitted using a species for which acute data is available using TGAI dicamba acid. Additionally, due to empirical mammalian data and predicted chronic toxicity to fish, chronic fish data should be submitted for DCSA with the same fish species used to fulfill the 850.1400 guideline with dicamba acid.
		Metabolite DCSA	No Data	N/A	Yes	
850.1400	Saltwater fish early-life stage	029801	No Data	N/A	No	No data are available for chronic effects of dicamba to saltwater fish. A saltwater fish early life stage study should be submitted using a species for which acute data is available using TGAI dicamba acid
850.1500	Fish life cycle	029801	No Data	N/A	No	--
850.4400	Aquatic plant Toxicity Test using Lemna spp.	029801	42774111	Invalid	Yes	Conditions in controls of the submitted study were inadequate to represent typical environmental conditions and may have adversely impacted control performance. A new study is needed using TGAI dicamba acid.
850.4500	Algal toxicity	029801	42774110	Acceptable	No	--
		029801	42774107	Acceptable	No	
		029801	42774108	Acceptable	No	
850.4550	Cyanobacteria	029801	42774109	Acceptable	No	--

Table 21. Submitted Terrestrial Ecological Effects Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.2100	Avian oral toxicity	029801	42774106 42774105	Acceptable	Yes	A passerine acute oral study is required as dicamba is moderately toxic on an acute basis to bobwhite quail and passerine species may be more sensitive than other taxa.
		029801	No Data	N/A		
		029802	00073275 00046180	Acceptable		
		128931	00263863	Invalid		
		129043	00261466	Supplemental-- Quantitative		
850.2200	Avian dietary toxicity	029801	42918001 42774105	Acceptable	No	--
		029802	00034693 00022527	Acceptable		
		029806	00068785	Acceptable		
		128931	00162071 00162072	Acceptable		
		129043	00261465 00261466	Supplemental-- Quantitative		
850.2300	Avian reproduction	029801	43814003	Acceptable	No	Chronic avian data (mallard duck preferred) with the metabolite DCSA is needed for the risk assessment. In the absence of chronic data, EPA will consider alternative approaches (<i>i.e.</i> using the difference between the chronic mammalian studies with dicamba and DCSA and comparing to the chronic mallard endpoint with dicamba acid.)
		Metabolite DCSA	No Data	N/A	Yes	
850.3020	Honey bee acute contact toxicity (Tier 1)	029801	00036935	Supplemental— Quantitative	No	--

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.3030	Honey bee residue on foliage (Tier 1)	029801	No Data	N/A	No	Data have not been submitted to fulfill this guideline. A data gap was not identified as these data are not necessary for risk assessment at this time since dicamba's acute contact LD ₅₀ was greater than the trigger of 11 µg/bee.
Non-guideline	Honey bee adult acute oral toxicity (Tier 1)	029801	No Data	N/A	Yes	No data is available assessing the oral exposure route for terrestrial invertebrates. A study should be submitted using TGAI dicamba acid. Although EPA has not developed a guideline for this study, OECD TG 213 may be used to satisfy the guideline requirement.
Non-guideline	Honey bee adult chronic oral toxicity (Tier 1)	029801	No Data	N/A	Yes	No data is available assessing the oral exposure route for terrestrial invertebrates. A study should be submitted using TGAI dicamba acid. Neither EPA nor OECD have an approved guideline for this study, but draft OECD guidance is in development. A protocol should be submitted prior to study initiation.
Non-guideline	Honey bee larval acute oral toxicity (Tier 1)	029801	No Data	N/A	Yes	In addition to the adult honey bee data gaps identified above, data is needed for the additional

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
Non-guideline	Honey bee larval chronic oral toxicity (Tier 1)	029801	No Data	N/A	Yes	honey bee life stage of larvae to complete the risk assessment for pollinators. Although EPA has not developed a guideline for these studies, OECD TG237 may be used to assess acute oral effects on larvae. Chronic (repeat dose) study guidance for assessing chronic oral toxicity to honey bee larvae is currently in development by OECD. A protocol should be submitted prior to study initiation.
Non-guideline	Magnitude of Residues in Pollen and Nectar	029801	No Data	N/A	Yes	Data have not been submitted to fulfill this guideline. Results from lower tier studies should inform the conduct of the field test to address remaining uncertainties. Pending the results of lower tier studies (adult honey bee acute oral, chronic adult honey bee, acute and chronic larval), magnitude of residue studies may not be needed to complete the risk assessment for pollinators. A protocol should be submitted prior to test initiation.

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.3040	Field testing for pollinators (Tier 2)	029801	No Data	N/A	Yes	Data have not been submitted to fulfill this guideline. Results from lower tier studies should inform the conduct of the field test to address remaining uncertainties. Pending the results of lower tier studies (adult honey bee acute oral, chronic adult honey bee, acute and chronic larval), a field testing study may not be needed to complete the risk assessment for pollinators. A protocol should be submitted prior to test initiation.
850.4100	Seedling Emergence and Seedling Growth	029801	42846301	Supplemental--Qualitative	Yes	The submitted data for dicamba acid were with TGAI and were conducted on plants grown in pure sand. New data are needed for representative TEP for dicamba acid using the standard suite of 10 species.
		029802	No Data	N/A	No	
		029803	No Data	N/A	No	
		029806	No Data	N/A	No	
		128931	47815101	Acceptable	No	
		128944	No Data	N/A	No	
		129043	No Data	N/A	No	
850.4150	Vegetative Vigor	029801	42846301	Supplemental--Qualitative	Yes	The submitted data for dicamba acid were with TGAI and were conducted on plants grown in pure sand. New data are needed for representative TEP for dicamba acid and all salts (except for DGA-salt), with 7 species (onion + 6 dicot species).
		029802	No Data	N/A	Yes	
		029803	No Data	N/A	Yes	
		029806	No Data	N/A	Yes	
		128944	No Data	N/A	Yes	
		129043	No Data	N/A	Yes	

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
		128931	47814102	Supplemental—Quantitative	Yes ¹	¹ For DGA-salt, acceptable data is available for all species except for lettuce, for which data is still needed.

12. References

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USEPA, 2016c. Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin). D416416+. Environmental Fate and Effects Division. Office of Pesticide Programs. Washington, D.C. March 24, 2016.

USEPA, 2016d. Addendum to Dicamba Diglycolamine (DGA) Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States (Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas). D422305. Environmental Fate and Effects Division, Office of Pesticide Programs, Office of Chemical Safety and Pollution Prevention. Washington, DC. March 24, 2016

USEPA, 2016e. Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 11 U.S. States: (Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia). D425049. Environmental Fate and Effects Division, Office of Pesticide Programs, Office of Chemical Safety and Pollution Prevention. Washington, DC. March 24, 2016

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Appendix A. Maximum Use Rate Information for Dicamba and its Associated Salts

Table A1. Maximum Labeled Use Rate Information for Dicamba Acid (PC Code 029801)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
GRASS (GROWN FOR SEED)	1.52	2.95	NS	NS	Broadcast
GRASS (FORAGE/FODDER/HAY), PASTURES, RANGELAND	1.50	3.01	2	30 day	Spot treatment
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE, AGRICULTURAL UNCULTIVATED AREAS	1.5	1.88	2	NS	Spot treatment, banded, broadcast (aerial, sprayer)
SOYBEANS	1.47	2.95	NS	NS	Broadcast, Spot Treatment
SUGARCANE	1.47	2.95	NS	NS	Broadcast (aerial, sprayer), banded, spot treatment, Wipe-on
ORNAMENTAL LAWNS & TURF, SOD FARMS	1.47	1.47	NS	30 day	Broadcast (aerial, sprayer), spot treatment, wipe-on
FOREST TREE MANAGEMENT/FOREST PEST MANAGEMENT	1.03	1.03	1	N/A	Broadcast (aerial & ground), Spot Treatment
CORN	0.74	1.10	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
ASPARAGUS	0.74	0.74	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
SORGHUM, WHEAT	0.37	0.74	NS	NS	Banded, Spot Treatment, Broadcast (aerial, sprayer)
BARLEY	0.37	0.55	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
COTTON	0.37	0.37	NS	NS	Broadcast (aerial, sprayer), banded, spot treatment
OATS, PROSO MILLET, TRITICALE	0.18	0.18	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
GOLF COURSE, RECREATION & RESIDENTIAL LAWNS	0.12	0.24	2	30 day	Broadcast (spreader)

NS-Not Specified

Table A2. Maximum Labeled Use Rate Information for Dicamba DMA salt (PC Code 029802)

Use Site	Maximum Rate (lbs a.e./Acre)		Max. No. of Apps/Year	Min. App. Interval	Application Methods/Comments
	Single	Annual			
NONAGRICULTURAL UNCULTIVATED AREAS/SOILS, AGRICULTURAL/FARM PREMISES, PASTURES, RANGELAND	2.42	2.42	NS	NS	Spot treatment
HAY (SILAGE)	2.42	2.42	NS	NS	Banded, spot treatment
SUGARCANE	2.42	2.42	NS	NS	Banded, Broadcast (aerial & ground), spot treatment, wipe-on
ORNAMENTAL SOD FARM (TURF)	2.35	2.35	NS	NS	Spot treatment
ORNAMENTAL LAWNS AND TURF	2.00	NS	2	30 days	Cut stem treatment
NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS	1.65	1.65	1	30 days	Spot treatment
AGRICULTURAL CROPS/SOILS (UNSPECIFIED), AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.21	2.42	NS	NS	Spot treatment, Broadcast (aerial, ground), Wipe-on.
GRASSES GROWN FOR SEED	1.21	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
GRASS FORAGE/FODDER/HAY	0.83	1.65	2	30 days	Spot treatment
CORN	0.60	0.91	NS	14 days	Banded, Broadcast (aerial, ground), Spot treatment, Wipe-on
ASPARAGUS	0.60	0.60	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
WHEAT	0.53 or 0.15	0.74 or 2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground). Max 2.42 lb/A annual rate is only for the lower max application rate (0.15 lb/A single)

Use Site	Maximum Rate (lbs a.e./Acre)		Max. No. of Apps/Year	Min. App. Interval	Application Methods/Comments
	Single	Annual			
HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES, ORNAMENTALS, PATHS/PATIOS, PAVED AREAS (PRIVATE ROADS/SIDEWALKS)	0.49	NS	2	NS	Spot treatment, Spot soil treatment
SORGHUM	0.42	NS	1	N/A	Banded, Spot treatment, Broadcast (aerial, ground)
SORGHUM	0.30	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground)
COTTON	0.30	NS	2	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
RECREATIONAL AREAS/LAWNS	0.22	NS	2	30 days	Broadcast (spreader)
GOLF COURSE TURF	0.19	NS	2	30 days	Spot treatment
BARLEY, OATS	0.15	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
TRITICALE	0.15	NS	2	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
COMMERCIAL/INDUSTRIAL LAWNS	0.09	NS	2	30 days	Spot treatment, broadcast (ground)

NS-Not Specified

Table A3. Maximum Labeled Use Rate Information for Dicamba DEA-salt (PC Code 0291803)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
SOYBEANS	1.00	NS	2	30 days	Spot treatment

Table A4. Maximum Labeled Use Rate Information for Dicamba Na-salt (PC Code 0291806)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
GRASSES GROWN FOR SEED	2.21	NS	NS	NS	Broadcast (aerial, ground)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.25	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SOYBEANS, SUGARCANE	1.25	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment
AGRICULTURAL/FARM PREMISES, HAY (SILAGE), NONAGRICULTURAL UNCULTIVATED AREAS/SOILS, ORNAMENTAL SOD FARM (TURF), PASTURES, RANGELAND,	1.25	1.25	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SMALL GRAINS	1.10	2.21	NS	NS	Broadcast (aerial, ground)
CORN	0.63	0.89	NS	14 days	Banded, Broadcast (aerial, ground), Wipe-on
ASPARAGUS	0.63	0.63	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded, Wipe-on
WHEAT	0.63	0.63	NS	NS	Wipe-on treatment
COTTON	0.31	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SORGHUM	0.31	0.63	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
BARLEY	0.31	0.44	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
GRASS FORAGE/FODDER/HAY	0.28	0.28	NS	NS	Broadcast (ground), Spot treatment
OATS, TRITICALE	0.16	0.16	NS	NS	Banded, Broadcast (aerial, ground), Spot treatment, Wipe-on
PROSO MILLET	0.14	0.14	NS	NS	Broadcast (aerial, ground)

Table A5. Maximum Labeled Use Rate Information for Dicamba DGA-salt (PC Code128931)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS, PASTURES,	3.05	3.05	NS	NS	Spot Treatment, Broadcast (aerial, ground), Banded, Wipe-on, Soil treatment, Spot soil

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
RANGELAND, SUGARCANE					
FOREST TREES (ALL OR UNSPECIFIED)	2.95	2.95	NS	NS	Broadcast (aerial, ground)
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.53	3.05	NS	NS	Spot Treatment, Broadcast (aerial, ground), Wipe-on, Banded, Spot soil treatment
GRASSES GROWN FOR SEED	1.53	3.05	NS	NS	Banded (ground), Spot Treatment, Broadcast (aerial, ground), Wipe-on
SOYBEANS	1.53	3.05	NS	NS	Banded, Spot Treatment, Broadcast (aerial, ground)
GOLF COURSE TURF	1.53	2.95	NS	NS	Broadcast (aerial, ground), Spot treatment (aerial, ground)
GRASS FORAGE/FODDER/HAY,	1.53	2.90	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded, Wipe-on, Basal bark treatment, Spot soil
ORNAMENTAL LAWNS AND TURF, ORNAMENTAL SOD FARM (TURF)	1.53	2.95	NS	30 days	Banded (aerial, ground), broadcast (aerial, ground), spot treatment, wipe-on
CORN, COTTON	1.48	2.98	NS	NS	Broadcast (aerial, ground), spot treatment, wipe-on, Banded
AGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/H EDGEROWS, INDUSTRIAL / CONSTRUCTION AREAS (OUTDOOR)	1.48	2.95	NS	NS	Low volume spray (concentrate), high volume spray (dilute), Broadcast (aerial), Spot treatment
RECREATIONA AREA LAWNS	1.48	2.95	NS	30 days	Broadcast (aerial, ground)
ASPARAGUS	0.76	0.76	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded (ground), Wipe-on
SMALL GRAINS	0.76	NS	NS	NS	Broadcast (aerial, ground), Spot treatment, Wipe-on, Banded
SORGHUM	0.38	2.98	NS	NS	Banded, Broadcast (aerial, ground), Spot treatment
WHEAT	0.38	0.76	NS	NS	Broadcast (aerial, ground), Spot treatment, Wipe-on, Banded
BARLEY	0.38	0.57	NS	NS	Broadcast (aerial, ground), Spot treatment (aerial, ground), Banded, Wipe-on
OATS, TRITICALE	0.19	0.19	NS	NS	Banded (aerial, ground), Broadcast (aerial, ground), Spot treatment, Wipe-on

Table A6. Maximum Labeled Use Rate Information for Dicamba IPA-salt (PC Code 128944)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
COTTON	1.28	1.60	NS	NS	Broadcast (aerial, sprayer), Spot treatment
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	0.35	0.35	NS	NS	Broadcast (aerial, ground), Spot treatment (ground), Spray (aerial, ground)
CORN	0.32	NS	2	14 days	Broadcast (aerial, sprayer), Directed spray, Spray (aerial, ground), Spot treatment
SMALL GRAINS	0.26	NS	NS	NS	Broadcast (aerial, sprayer), Spot treatment
WHEAT	0.23	NS	2	30 days	Spray (aerial, ground), low volume spray—concentrate (aerial, ground), Spot treatment
AGRICULTURAL/FARM PREMISES, FENCEROWS/HEDGE ROWS	0.22	NS	2	NS	Broadcast (ground)
BARLEY	0.22	NS	NS	NS	Spray (aerial, ground), Low volume spray—concentrate (aerial, ground)
OATS	0.16	NS	2	30 days	Spray (aerial, ground), low volume spray—concentrate (aerial, ground), Spot treatment
SORGHUM	0.16	NS	2	30 days	Spray (aerial, ground), litter and bedding treatment, Low volume—concentrate (ground)
PASTURES, RANGELAND	0.11	NS	2	30 days	Broadcast (aerial, ground), Spot treatment
NONAGRICULTURAL RIGHTS-OF-WAY, NONAGRICULTURAL UNCULTIVATED AREAS/SOILS	0.07	NS	NS	NS	Broadcast (ground)

Appendix B- SIP and STIR Outputs

SIP—Dicamba

Table 1. Inputs

Parameter	Value
Chemical name	Dicamba
Solubility (in water at 25°C; mg/L)	6100
Mammalian LD ₅₀ (mg/kg-bw)	2740
Mammalian test species	laboratory rat
Body weight (g) of "other" mammalian species	
Mammalian NOAEL (mg/kg-bw)	136
Mammalian test species	laboratory rat
Body weight (g) of "other" mammalian species	
Avian LD ₅₀ (mg/kg-bw)	188
Avian test species	northern bobwhite quail
Body weight (g) of "other" avian species	
Mineau scaling factor	1.15
Mallard NOAEC (mg/kg-diet)	695
Bobwhite quail NOAEC (mg/kg-diet)	1390
NOAEC (mg/kg-diet) for other bird species	
Body weight (g) of other avian species	
NOAEC (mg/kg-diet) for 2nd other bird species	
Body weight (g) of 2nd other avian species	

Table 2. Mammalian Results

Parameter	Acute	Chronic
Upper bound exposure (mg/kg-bw)	1049.2000	1049.2000
Adjusted toxicity value (mg/kg-bw)	2107.5000	104.6058
Ratio of exposure to toxicity	0.4978	10.0300
Conclusion*	Exposure through drinking water alone is a potential concern for mammals	Exposure through drinking water alone is a potential concern for mammals

Table 3. Avian Results

Parameter	Acute	Chronic
Upper bound exposure (mg/kg-bw)	4941.0000	4941.0000
Adjusted toxicity value (mg/kg-bw)	135.4407	34.4807
Ratio of exposure to acute toxicity	36.4809	143.2974
Conclusion*	Exposure through drinking water alone is a potential concern for birds	Exposure through drinking water alone is a potential concern for birds

*Conclusion is for drinking water exposure alone. This does not combine all routes of exposure. Therefore, when aggregated with other routes (*i.e.*, diet, inhalation, dermal), pesticide exposure through drinking water may contribute to a total exposure that has potential for effects to non-target animals.

Table 3. STIR Inputs and Outputs

Input		
Application and Chemical Information		
Enter Chemical Name	Dicamba	
Enter Chemical Use	Reg Review (many)	

Is the Application a Spray? (enter y or n)	y		
If Spray What Type (enter ground or air)	air		
Enter Chemical Molecular Weight (g/mole)	221		
Enter Chemical Vapor Pressure (mmHg)	3.41E-05		
Enter Application Rate (lb a.i./acre)	3.05		
Toxicity Properties			
Bird			
Enter Lowest Bird Oral LD ₅₀ (mg/kg bw)	188		
Enter Mineau Scaling Factor	1.15		
Enter Tested Bird Weight (kg)	0.178		
Mammal			
Enter Lowest Rat Oral LD ₅₀ (mg/kg bw)	2740		
Enter Lowest Rat Inhalation LC ₅₀ (mg/L)	5.3		
Duration of Rat Inhalation Study (hrs)	4		
Enter Rat Weight (kg)	0.35		
Output			
Results Avian (0.020 kg)			
Maximum Vapor Concentration in Air at Saturation (mg/m ³)	4.06E-01	Exposure not Likely Significant	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	5.10E-02		
Adjusted Inhalation LD ₅₀	2.03E+00		
Ratio of Vapor Dose to Adjusted Inhalation LD ₅₀	2.51E-02		
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	2.93E-01		
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD ₅₀	1.45E-01	Proceed to Refinements	
Results Mammalian (0.015 kg)			

Maximum Vapor Concentration in Air at Saturation (mg/m ³)	4.06E-01	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	6.41E-02	
Adjusted Inhalation LD ₅₀	3.16E+02	
Ratio of Vapor Dose to Adjusted Inhalation LD ₅₀	2.03E-04	Exposure not Likely Significant
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	3.68E-01	
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD ₅₀	1.17E-03	Exposure not Likely Significant



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Codes: 029801, 029802, 029803, 029806, 128931, 129043, 128944

DP Barcode: 426710

Date: June 13, 2016

MEMORANDUM

SUBJECT: Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba

FROM: Michael Wagman, Biologist
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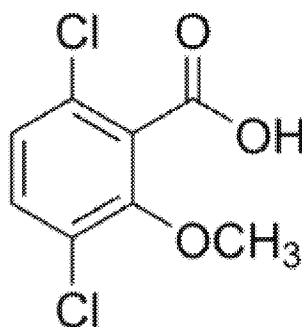
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Office of Chemical Safety
and Pollution Prevention

**Problem Formulation for the Environmental Fate, Ecological Risk,
and Drinking Water Exposure Assessments in Support of the
Registration Review of Dicamba**



3,6-Dichloro-*o*-anisic acid, salts and esters

CAS Registry Number: 1918-00-9

PC Codes: 029801, 029802, 029803, 029806, 128931, 128944, 129043

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June 13, 2016

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1. Executive summary

The Environmental Fate and Effects Division (EFED) has completed the preliminary problem formulation for the ecological risk, environmental fate, and drinking water assessments to be conducted as part of the registration review of dicamba. This action includes dimethylamine salt (DMA-salt, PC code 029802), diethanolamine salt (DEA-salt, PC code 029803), sodium salt (Na-salt, PC code 029806), diglycoamine salt (DGA-salt, PC code 128931), potassium salt (K-salt, PC code 129043), isopropylamine salt (IPA-salt, PC code 128944) and dicamba acid (dicamba, PC code 029801). Dicamba monoethanolamine salt, triethanolamine salt, methoxybenzoic acid, and aluminum salt were not included in this action as there are no current product registrations for these active ingredients. The problem formulation describes the methods planned to be used during the completion of drinking water and ecological risk assessments in support of registration review and provides an overview of the environmental fate, ecological effects, and potential risks associated with the use of dicamba as well as uncertainties unique to the risk assessment of dicamba. This document also identifies additional studies that would be beneficial to the conduct of an ecological risk assessment. Major findings include:

Data needs for dicamba ecological effects are:

Data on parent dicamba (test guidelines and PC codes in parentheses):

- *Oyster Acute Toxicity Test (shell deposition, OCSPP guideline 850.1025) using TGAI, dicamba acid (029801)*
- *Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)*
- *Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)*
- *Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available*
- *Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species*
- *Seedling Emergence and Seedling Growth (850.4100) using TEP, dicamba acid (029801) on standard suite of 10 terrestrial plant species*
- *Vegetative Vigor (850.4150) using TEP, dicamba acid (029801), DMA-salt (029802), DEA-salt (029803), Na-salt (029806), K-salt (129043) and IPA salt (128944) with 7 terrestrial plant species (onion + 6 dicot species). For DGA-salt (128931), 1 species (lettuce) is required.*
- *Aquatic Plant Toxicity Test Using Lemna spp. (850.4400) using TGAI, dicamba acid (029801)*
- *Tier 1 Adult Honey Bee Acute Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Larval Honey Bee Acute Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Larval Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*

- *Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.*
- *Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies*

In addition, the following effects data is needed for dicamba's major degradate, DCSA:

- *Fish Early-Life Stage Toxicity Test (850.1400) using dicamba's metabolite, DCSA and the same species as used in the test with TGA dicamba.*
- *Daphnid Chronic Toxicity Test (850.1300) using dicamba's metabolite, DCSA.*
- *Avian Reproduction Test (850.2300) using dicamba's metabolite, DCSA and the mallard duck*

Data needs for environmental fate and exposure assessment are:

Data on parent dicamba:

- *Environmental Chemistry Methods and independent laboratory validations for dicamba and DCSA in Soil and Water (850.6100)*
- *Laboratory Volatility (835.1410) for each registered salt and ester formulation intended for use on GMO crops*
- *Field Volatility (835.8100) for each registered salt and ester formulation intended for use on GMO crops.*
- *Spray Droplet Size Spectrum (840.1100) and Spray Drift Field Deposition (835.1200) for each formulation intended for use on GMO crops.*
- *For parent dicamba, additional data on aerobic soil metabolism (835.4100) with US soils.*
- *For parent dicamba, additional data on aerobic aquatic metabolism (835.4300, currently only one study submitted).*

In addition, the following fate data is needed for dicamba's major degradate, DCSA:

- *For the major degradate, dichlorosalicylic acid (DCSA), additional data on aerobic soil metabolism (835.4100).*
- *For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).*

Major uncertainties:

Spray drift was the major route of exposure considered in the risk assessments for dicamba use on GMO cotton and soybeans. Any new formulations for which an Endangered Species Act effect determination must be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300).

Post-application volatilization of dicamba as the acid was a major uncertainty in risk assessments for use on GMO cotton and soybeans. Several formulations of dicamba are intended to reduce volatilization of dicamba in the first few days after application, but the ability of these formulations to delay the formation of the volatile dicamba acid, under a range of environmental conditions, is not well understood. It is also not understood whether off-site movement due to

volatilization is as great as from spray drift at the time of application. Field volatility tests (835.8100) will reduce this uncertainty.

Some GMO crops detoxify dicamba by metabolizing it to 3,6-dichlorosalicylic acid (3,6-DCSA), which is more toxic than parent dicamba to some taxa, including mammals. DCSA is a major degradate under anaerobic aquatic metabolism conditions. Additional chronic toxicity tests using this degradate are required for daphnids, fish and birds.

2. Introduction

Dicamba is a systemic herbicide in the benzoic acid chemical class similar in structure and mode of action to phenoxy herbicides. Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

The use information presented in this problem formulation was obtained from the tables in the EFED Label Data Report dated 6/22/2015, from BEAD's Chemical Profile for Registration Review (USEPA, 2015), and from various evaluated labels. Across the acid and six salts with active registrations, there are a total of 479 end use registrations

Recent labels (*e.g.* the M1691 label, EPA Reg. No. 524-582, containing dicamba DGA salt) contain environmental hazard information regarding the known potential for dicamba to leach into groundwater under certain conditions, such as where soils are permeable or the water table is shallow, but this language does not appear on older labels.

The following labeling statement appears on all dicamba labels to avoid contamination of aquatic environments and drinking water from use on agricultural products.

ENVIRONMENTAL HAZARD STATEMENTS

Keep out of lakes, streams or ponds. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high watermark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on label.

3. Use Characterization

Dicamba is a systemic herbicide in the benzoic acid chemical class similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves. Dicamba was first registered in the United

States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures.

It is registered for use on agricultural crop soils for the following: asparagus, barley, corn, cotton, fallow, grasses grown for seed/forage/fodder/hay, oats, proso/millet, sorghum, soybeans, sugarcane, triticale, wheat, pasture/rangeland and forestry. It is also registered for use on non-agricultural use sites including farm and domestic premises, conservation reserve program land, commercial/industrial lawns, recreational/residential lawns, golf course turf, rights-of-way, fencerows and hedgerows, ornamental herbaceous plants, ornamental woody shrubs and vines, ornamental lawns and turf, ornamental sod (turf), paved areas and paths/patios. On soybean and cotton, it is registered for both pre-emergent use and, on dicamba-tolerant soy and cotton plants only, for post-emergent use as well.

Dicamba is formulated as emulsifiable, soluble concentrate, granular, wetted powder, FIC, and as a solution-ready-to-use. Dicamba can be applied by broadcast spray (aerial and ground), spot treatment, banded, wipe on/wipe off treatment, cut-stem treatments and as a basal bark treatment. The Screening Level Usage Analysis (SLUA) produced by BEAD (**Table 1**, compiled on June 22, 2015) indicates that the greatest uses of dicamba are on corn (1.5 million pounds per year, used on an average of 10% of the crop), pasture and fallow (1.1 million pounds per year) and wheat (500,000 pounds per year used on an average of 10% of the crop).

Table 1. Screening Level Estimates of Agricultural Uses of Dicamba (PC codes: 029801, 029802, 029803, 029806, 128931, 129043, and 128944). Based on reporting years from 2004—2013.

	Crop	Annual Average	Percent Crop Treated	
		Lbs. A.I.	Average	Maximum
1	Alfalfa+	2,000	<1	<2.5
2	Asparagus	<500	5	10
3	Barley	20,000	5	10
4	Canola+	2,000	<2.5	10
5	Corn	1,500,000	10	15
6	Cotton	200,000	5	15
7	Dry Beans/Peas+	3,000	<2.5	<2.5
8	Fallow	500,000	15	35
9	Oats	6,000	<2.5	<2.5
10	Pasture	600,000	<2.5	5
11	Peanuts+	1,000	<1	<2.5
12	Pecans+	1,000	<2.5	<2.5
13	Rice	3,000	<1	<2.5
14	Sorghum	200,000	15	25
15	Soybeans	100,000	<2.5	<2.5
16	Squash+	<500	<2.5	<2.5
17	Sugarcane	40,000	20	25

18	Sunflowers+	9,000	5	10
19	Sweet Corn	<500	<1	<2.5
20	Wheat	500,000	10	25

A number of labels for use in agricultural fallow/conservation reserve land, barley, cotton, forestry, pastures, rangeland, ornamental turf and soybeans do not specify the maximum number of applications per year. Without clarification of the labels or details on usage in these use sites, conservative assumptions will be made.

The tables in **Appendix A** summarize use patterns for dicamba acid (PC code 029801; MW: 221.0 g/mol), the DMA-salt of dicamba (PC code 029802; MW: 226.1 g/mol), the DEA-salt of dicamba (PC code 029803; MW: 326.18), the Na-salt of dicamba (PC code 029806; MW 243.0 g/mol), the DGA-salt of dicamba (PC code 128931; MW: 326.18), the IPA-salt of dicamba (PC code 128944, MW: 280.04 and the K-salt of dicamba (PC code 129043; MW: 259.1 g/mol). Though these are distinct chemical moieties, they will be assessed together using the acid equivalence (a.e.) method. That is, only the dicamba acid component will be assessed and the application rates of the DMA-salt, the DEA-salt, the Na-salt, the DGA-salt, the IPA-salt and the K-salt will be adjusted to account for only dicamba acid.

4. Conclusions from Previous Risk Assessments

4.1. Ecological Risk Assessment

The most recent ecological risk assessments conducted on dicamba or its associated salts were the 2016 risk assessment for the use of dicamba DGA salt on dicamba-tolerant (DT-) cotton (USEPA, 2016a; D404823), an addendum to the use of dicamba DGA salt on dicamba-tolerant (DT-) soybean (USEPA, 2016b; D426789) and refined endangered species assessments for 34 states (USEPA, 2016c-e; D416416+, D422305, D425049) for the use of DGA salt on dicamba-tolerant soybeans and cotton. The Tier I risk assessment on DT-cotton and the addendum on DT-soybean identified that potential direct risk concerns could not be excluded for mammals (chronic, due to residues of dicamba's metabolite, DCSA in DT-soybean), birds (acute for both uses from parent dicamba, chronic in soybean only, due to DCSA residues in DT-soybeans) and terrestrial plants (both uses, from parent dicamba). Residues of DCSA in DT-soybean plant tissues were found to be higher than residues of parent dicamba and persisted longer. These documents also addressed concerns regarding the potential for dicamba to move off-site through spray drift, volatility and run-off and specified an in-field buffer (designed to keep dicamba residue concentrations above which could cause adverse effects restricted to the field) specific to the tested DGA-salt formulation (M1691, EPA Reg No. 524-582) with specific nozzle requirements intended to restrict the droplet spectra to ultra-coarse and extremely coarse sized droplets.

EFED completed the reregistration chapter for dicamba/dicamba salts in 2005 (USEPA, 2005). The RED assessment determined that bridging data indicate that dicamba salts will rapidly convert to the free acid of dicamba and that the submitted ecological effects data generally

indicate similar toxicity of the acid and salts (based on acid equivalents). Therefore, EFED concluded that environmental fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. However, the EFED RED chapter also identified data gaps for seedling emergence and vegetative vigor studies for dicamba acid and all salts, using typical end-use products (TEP) and requested these studies for the 5 most sensitive species in available plant tests with technical grade active ingredient (TGAI) dicamba acid (soybean, onion, turnip, tomato and lettuce). Seedling emergence and vegetative vigor data were subsequently submitted and determined to be acceptable for dicamba DGA salt, but not for any of the other salts or for a dicamba acid TEP.

4.2. *Drinking Water Exposure Assessments*

A comprehensive drinking water assessment was performed for dicamba at the time of the RED in 2005. Later assessments for new uses on sweet corn and sugarcane were done in 2005 and 2007.

A new drinking water assessment will be performed for Registration Review, because both the models and guidance for such assessments has changed considerably since 2005. This will include a new ground water assessment with PRZM-GW, as part of the Pesticides Water Calculator (PWC).

The new assessment will address the degradate DCSA (dichlorosalicylic acid), which is formed in greater amounts by crops engineered to be resistant to dicamba.

4.3. *Clean Water Act Programs*

Dicamba is not identified as a cause of impairment for any water bodies listed as impaired under section 303(d) of the Clean Water Act. No Total Maximum Daily Load (TMDL) criteria have been developed for dicamba. Aquatic benchmarks have been established for dicamba acid and its dimethylamine (DMA) and sodium salts and are available at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-pesticide-registration>. Any data submitted or otherwise located as part of the registration review process may be used to update aquatic life benchmarks if applicable.

5. Environmental Fate and Transport

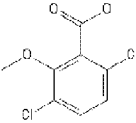
Dicamba as the acid is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs ($pK_a = 1.9$). Dicamba is not stable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization. It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target

plant injury.¹ Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major routes of exposure to non-target organisms is likely spray drift, runoff and volatilization. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in **Table 2**. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the cited documents (USEPA, 2005 and USEPA, 2011). Physical properties of dicamba acid are given in **Table 3**. Aquatic modeling input parameters are given for dicamba acid in **Table 4** and for 3,6-DCSA in **Table 5**.

Table 2. Chemical Structures Relevant to this Assessment

<p>Dicamba acid <chem>COc1c(Cl)ccc(Cl)c1C(=O)O</chem></p>	
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¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

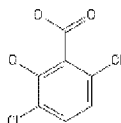
3,6-dichlorosalicylic acid (DCSA)	
<chem>C1(=C(C(=CC=C1Cl)Cl)O)C(=O)O</chem>	

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))
Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZ Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)

Vapor Pressure	3.41 E-05 torr (25°C) SANDOZ Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

TABLE 4. Fate Data for Dicamba.

Model Input Variable	Input Value	Source and Comments
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. Fate Data for Dicamba's Metabolite, DCSA.

Model Input Variable	Input Value	Source and Comments
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

6. Receptors

Tables 6 through 16 provide a summary of the aquatic and terrestrial taxonomic groups, and the most sensitive surrogate species tested to characterize the potential acute and chronic ecological effects of dicamba and its associated salts. In addition, the tables provide a preliminary overview of the potential acute toxicity of dicamba and its associated salts by providing the acute toxicity classifications. In the following tables, the toxicity endpoint values for all the salts have been converted to dicamba acid equivalents to facilitate comparison between the different forms and these values will be used in the risk assessment.

6.1. *Effects to Aquatic Organisms*

Tables 6-11 show the most sensitive available aquatic toxicological data for dicamba acid and its associated salts adjusted to acid equivalents. No aquatic ecotoxicity data are available for the diethanolamine salt (PC code 029803). Based on the available ecotoxicity information, dicamba and its associated salts are practically non-toxic to slightly toxic on an acute basis to estuarine/marine and freshwater fish (dicamba acid appearing to be the most toxic) and generally practically non-toxic to freshwater and estuarine/marine invertebrates, except for one TEP study with dicamba Na-salt (MRID 00085935) that indicated this formulation was moderately toxic on an acute basis to freshwater invertebrates (48-hr EC₅₀ of 9.2 mg a.e./L. Given that dicamba salts should disassociate to the acid rapidly in water, and the evident lack of toxicity observed in all the other available freshwater invertebrate studies, it is likely that the observed toxicity in this study is due to effects from the formulation, rather than toxicity specific to the sodium salt. However, this value could potentially be used qualitatively as a conservative estimate of toxicity across dicamba acid and other salts in the risk assessment. No acute data are available for assessing the toxicity of dicamba or its associated salts to estuarine/marine mollusks and no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this uncertainty. For aquatic plants, dicamba appears to be more toxic to non-vascular plants than to vascular plants, however there is some uncertainty to this as the available study with duckweed (MRID 42774111) was initiated with highly acidic

conditions (pH 4.9-5.0) which may have impacted control performance and masked any treatment-related effects. Therefore, a new study with duckweed is requested at this time.

No acute or chronic aquatic toxicological data is available for dicamba's metabolite, DCSA, though the EU's footprint database² reports similar acute toxicity of DCSA to parent dicamba and significantly lower toxicity of DCSA to aquatic plants. Ecosar v1.1, a model predicting toxicity based on a chemical's molecular structure predicts DCSA to be both at least 30 times more toxic on a chronic basis than parent dicamba to fish and several orders of magnitude more toxic than parent dicamba to freshwater invertebrates using the neutral organic chemical class for comparison. The uncertainty in using the neutral organic Ecosar class for the acids, dicamba and DCSA, is acknowledged. Additionally, as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA. Given the known increased chronic toxicity of the degradate to mammals compared to parent dicamba and the model's predicted chronic toxicity differential to fish and invertebrates based on the chemical structures of the parent and degradate, the lack of chronic data for fish and invertebrates potentially exposed to the major metabolite DCSA is considered a major data gap.

Table 6. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for Dicamba acid (PC Code 029801)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source/Classification
Freshwater fish ¹	Acute	TGAI 88%	Rainbow trout (<i>Oncorhynchus mykiss</i>)	96-hr LC ₅₀ = 28 mg a.e./L Nominal	Slightly toxic	MRID 40098001/ Supplemental — Quantitative
	Chronic (Early Life-Stage)	--	No Data	N/A	N/A	N/A
Freshwater invertebrates	Acute	TGAI 88%	Water Flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ > 100 mg a.e./L Nominal	Practically non-toxic	MRID 40098001/ Supplemental — Quantitative
	Chronic	--	No Data	No Data	N/A	N/A
Estuarine/marine fish	Acute	TGAI 86.8%	Sheepshead minnow (<i>Cyprinodon variegates</i>)	96-hr LC ₅₀ > 180 mg a.e./L Nominal	Practically non-toxic	MRID 00025390/ Acceptable
	Chronic	--	No Data	N/A	N/A	N/A

² Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>). This database reports acute fish and freshwater invertebrate endpoints of > 100 mg/L and 89 mg/L, respectively and aquatic plant EC₅₀s of >73 mg/L and 138 mg/L for vascular and non-vascular aquatic plants.

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source/Classification
Estuarine/marine invertebrates	Acute	TGAI 86.8%	Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	Practically non-toxic	MRID 00034702/ Acceptable
	Chronic	--	No Data	N/A	N/A	N/A
	Acute	--	No Data	No Data	N/A	--
Aquatic plants and algae	Vascular	--	No Data	N/A	N/A	--
	Non-vascular	TGAI 89.5%	Marine Diatom (<i>Skeletonema costatum</i>)	120-Hr EC ₅₀ = 0.493 mg ae/L (0.09—4.1) NOAEC = 0.011 mg ae/L Mean-measured	N/A	MRID 42774110/ Acceptable

¹ Freshwater fish are surrogates for aquatic-phase amphibians.

Table 7. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for Dicamba dimethylamine salt (PC Code 029802)

Taxonomic Group	Study Type	TGAI/TEP % Dicamba ae	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 11.5%	Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i>	96-Hr LC ₅₀ > 112.4 mg ae/L	Practically non-toxic	MRIDs 00046183 00046184/ Acceptable
Freshwater invertebrates	Acute	TEP 48.2%	Water Flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ = 1563 mg a.e./L (1270—1856)	Practically non-toxic	MRID 00028283/ Acceptable

Table 8. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba sodium salt (PC Code 029806)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 22%	Rainbow Trout (<i>Oncorhynchus mykiss</i>)	96-Hr LC ₅₀ = 111.6 mg ae/L (436.3—589.9) Nominal	Practically non-toxic	MRID 00029623/ Acceptable
Freshwater invertebrates	Acute	TEP 26.5%	Water flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ = 9.2 mg ae/L	Moderately toxic	MRID 00085935 Acceptable

Table 9. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba DGA salt (PC Code 128931)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 40.2%	Rainbow Trout (<i>Oncorhynchus mykiss</i>) & Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ > 270.8 mg ae/L Nominal	Practically non-toxic	MRIDs 00162068 00162067/ Acceptable
Freshwater invertebrates	Acute	TEP 40.2%	Water flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ > 270.8 mg ae/L	Practically non-toxic	MRID 00162069/ Supplemental — Quantitative

Table 10. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba K salt (PC Code 129043)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source (Classification)
Freshwater fish	Acute	TEP 38%	Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ = 73.2 mg ae/L Nominal	Practically non-toxic	ACCN 00258932/ Supplemental — Qualitative
Freshwater invertebrates	Acute	TEP 40.2%	Water flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ = 301 mg ae/L Nominal	Practically non-toxic	ACCN 00258983/ Supplemental — Qualitative

Table 11. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba IPA salt (PC Code 128944)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source (Classification)
Freshwater fish	Acute	TEP 32.5%	Rainbow trout (<i>Oncorhynchus mykiss</i>) & Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ > 256 mg a.e./L Nominal	Practically non-toxic	MRIDs 00265440 00265441/ Acceptable
Freshwater invertebrates	Acute	TEP 32.5%	Water flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ > 256 mg a.e./L Nominal	Practically non-toxic	MRID 00265442/ Supplemental — Quantitative

6.2. *Effects to Terrestrial Organisms*

Tables 12-17 show the most sensitive available terrestrial toxicological data for dicamba acid and its associated salts. No terrestrial ecotoxicity data are available for the DEA-salt (PC code 029803) or the IPA-salt (PC code 128944). On an acute oral basis to birds, the toxicity of dicamba and its associated salts ranges from practically non-toxic to moderately toxic, with dicamba acid having the most sensitive endpoint. No acute oral data is available for dicamba's toxicity to passerine birds, which have the potential to be more sensitive than the tested surrogate species (bobwhite quail). On an acute dietary basis to birds, treatment-related effects and mortalities were generally not observed even at the highest tested doses, leading to non-definitive (*i.e.* greater than) LC₅₀s and sub-acute toxicity classifications of practically non-toxic to slightly toxic. The only sensitive chronic avian endpoint was for mallard ducks (21-week NOAEC of 695 mg a.e./kg-diet.) based on moderate (11-21%) inhibitions in the number of hatchlings, 14-day old chicks and 14-day old chicks as a percentage of eggs laid in the 1390 mg a.i./kg-diet treatment group compared to the control group. However, these reductions were not statistically significant and potentially could be due to natural variability. Therefore, it is possible that this endpoint may overestimate the chronic toxicity of dicamba to avian species.

Dicamba is practically non-toxic to mammals on acute oral basis. Chronic effects observed in the 2-generation rat study were based on neurotoxicity, delayed maturation of the F₀ generation, and decreased pup weight in both the F₁ and F₂ generations at 450 mg a.e./kg-diet. Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees. This is considered a major data gap.

For terrestrial plants, no acceptable data are available for TEPs with dicamba acid or any of its associated salts, with the exception of the DGA-salt. A seedling emergence and vegetative vigor study with dicamba acid (MRID 42846301), is considered supplemental due to the use of TGAI instead of TEP and since the test plants were cultivated in support media of pure sand with 0.11-0.17% organic matter rather than soil and is not representative of more typical conditions that plants exposed to dicamba may face. Though the plants in the study were bottom-watered, there is nonetheless concern that some dicamba may have leached downward in the sand, resulting in uncertainty as to the actual exposures the plants received. Therefore, new vegetative vigor data is needed for representative TEPs of each salt (other than the DGA salt) and dicamba acid as well as seedling emergence data for dicamba acid. For dicamba DGA salt, the submitted seedling emergence and vegetative vigor studies were acceptable (MRIDs 47815101 and 47815102), but new vegetative vigor data are needed for lettuce only, due to poor performance of lettuce control plants in the available vegetative vigor study.

Table 18 shows the available terrestrial toxicological data for dicamba's metabolite, DCSA. Mammalian data indicate that DCSA has similar acute toxicity as parent dicamba, but is significantly more toxic on a chronic basis with statistically significant inhibitions (6-9%) in 14-21 post-natal days pup weight at the 37 mg/kg/d treatment group, relative to controls, and a corresponding NOAEL of 4 mg/kg/d based on male pre-mating doses. A recent benchmark dose analysis conducted by HED (USEPA, 2016f) determined benchmark doses based on both male pre-mating doses and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup

body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. In the risk assessment, EPA will use the 8 mg/kg/d NOAEL based on dam lactation doses as the chronic mammalian endpoint.

No chronic data are available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). In the absence of additional data, as a conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch. However, chronic avian reproduction data with DCSA would decrease the uncertainty associated with this approach.

Table 12. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba acid (PC Code 029801)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds ¹	Acute oral	86.9%	Bobwhite quail (<i>Colinus virginianus</i>)	LD ₅₀ = 188 mg a.e./kg-bw (141—250) Slope = 6.0 (2.6—9.3)	Moderately toxic	MRIDs 42918001 42774105 (Acceptable)
	Acute oral (passerine)	--	No Data	No Data	N/A	--
	Sub-acute dietary	86.8%	Bobwhite quail (<i>Colinus virginianus</i>)	8-D LC ₅₀ > 8,680 ppm a.e.	Practically non-toxic	MRID 00025391 (Acceptable)
	Chronic	86.9	Mallard duck (<i>Anas platyrhynchos</i>)	NOAEC = 695 ppm a.e. LOAEC = 1390 ppm a.e. Reduced Hatch, and Chick Survival	N/A	MRID 43814003 (Acceptable)
Mammals	Acute Oral	TGAI 99.7%	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg/kg (males) (2010-3740)	Practically non-toxic	MRID 00078444 (Acceptable)
	Acute Inhalation	TEP	Laboratory rat (<i>Rattus norvegicus</i>)	4-Hr LC ₅₀ > 5.3 mg a.e./L	IV	MRID 00263861 (Acceptable)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Subchronic Feeding	TGAI 86.8%	Laboratory rat (<i>Rattus norvegicus</i>)	13-Wk NOEL: 500 mg/kg/d LOEL: 1000 mg/kg/day Endpoints: body wt. changes, liver effects	N/A	MRID 00128093 (Acceptable)
	Chronic (2-Generation Reproduction)	TGAI 86.9%	Laboratory rat (<i>Rattus norvegicus</i>)	NOAEL = 136 mg ae/kg-diet/day LOAEL = 450 mg a.e./kg-diet/day Endpoints: neurotoxicity, delayed maturation of F0 gen, decreased pup weight	N/A	MRID 43137101 (Acceptable)
Terrestrial Invertebrates	Acute contact (adult)	TEP % ai unknown	Honey bee (<i>Apis mellifera</i> L.)	48-hr LD ₅₀ > 90.65 µg/bee	Practically non-toxic	MRID 00036935 (Supplemental —Quantitative)
	Acute oral (adult)	--	No Data	No Data	N/A	--
	Chronic oral (adult)	--	No Data	No Data	N/A	--
	Acute larval	--	No Data	No Data	N/A	--
	Chronic larval	--	No Data	No Data	N/A	--
Terrestrial plants	Seedling Emergence	--	No Data	No Data	N/A	MRID 42846301 (Supplemental —Qualitative)
		--	No Data	No Data	N/A	MRID 42846301 (Supplemental —Qualitative)
	Vegetative Vigor	--	Monocot – No Data	No Data	N/A	--
		--	Dicot – No Data	No Data	N/A	--

¹ Birds are considered a surrogate for terrestrial phase amphibians and reptiles

Table 13. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba DMA-salt (PC Code 029802)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	TEP 11.5%	Mallard Duck <i>Anas platyrhynchos</i>	14-D LD ₅₀ > 282 a.e./kg-bw	Practically non-toxic	MRIDs 00046180 (Acceptable)
	Sub-acute dietary	TEP 48.2%	Bobwhite quail <i>Colinus virginianus</i> & Mallard Duck <i>Anas platyrhynchos</i>	8-D LC ₅₀ > 2,185 ppm a.e.	Practically non-toxic	MRIDs 00034693 00022527 (Acceptable)

Table 14. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba Na-salt (PC Code 029806)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Sub-acute dietary	TEP 26.5%	Bobwhite quail <i>Colinus virginianus</i>	8-D LC ₅₀ > 2,409 ppm a.e.	Slightly toxic	MRID 00068785 (Acceptable)

Table 15. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba DGA-salt (PC Code 128931)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	No Data ¹	--	N/A	No Data	No Data

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Sub-acute dietary	TEP 40%	Bobwhite quail <i>Colinus virginianus</i> & Mallard Duck <i>Anas platyrhynchos</i>	8-D LC ₅₀ > 609 ppm a.e.	Slightly Toxic	MRIDs 00162071 00162072 (Acceptable)
Terrestrial plants	Seedling Emergence	TEP 40.3%	Monocot – Onion (<i>Allium cepa</i>)	EC ₂₅ = 1.68 lb ae/A NOAEC = 0.64 lb ae/A	N/A	MRID 47815101 (Acceptable)
		TEP 40.3%	Dicot – Soybean (<i>Glycine max</i>)	EC ₂₅ = 0.170 lb ae/A NOAEC = 0.0702 lbs ae/A	N/A	
	Vegetative Vigor	TEP 40.3%	Monocot – Onion (<i>Allium cepa</i>)	EC ₂₅ = 0.472 lbs ae/A EC ₀₅ = 0.137 lbs ae/A	N/A	MRID 47815101 (Acceptable)
		TEP 40.3%	Dicot – Soybean (<i>Glycine max</i>)	EC ₂₅ = 0.000513 lb ae/A NOAEC = 0.000261 lb ae/A	N/A	

¹ Previously, a study with the bobwhite quail (MRID 00162070) was deemed to be acceptable with an LD₅₀ of 387.2 ppm a.e. However, regurgitation occurred at several doses, including the lowest dose (117 ppm a.e.). The regurgitation did not follow a dose response, and this study has been downgraded to invalid.

Table 16. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba K-salt (PC Code 129043)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	TEP 38%	Bobwhite quail (<i>Colinus virginianus</i>)	14-D LD ₅₀ = 235 mg a.e./kg-bw	Moderately toxic	MRID 00261466 (1986) Supplemental-- Quantitative

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Sub-acute dietary	TEP 38%	Bobwhite quail (<i>Colinus virginianus</i>) & Mallard duck (<i>Anas platyrhynchos</i>)	8-D LC ₅₀ > 1,822 ppm a.e.	Slightly toxic	MRIDs 00261465 00261466 (Supplemental--Quantitative)

Table 17. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba's Metabolite, DCSA.

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Mammals	Acute Oral	TGAI 99.7%	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 mg/kg (males)	Practically non-toxic	MRID 47899504 (Acceptable)
	Chronic (2-Generation Reproduction)	TGAI 86.9%	Laboratory rat (<i>Rattus norvegicus</i>)	NOAEL = 8 mg ac/kg-diet/day LOAEL = 78 mg a.e./kg-diet/day, using female lactation doses Endpoints: decreased pup weight	N/A	MRID 47899517 (Acceptable)

6.3. Ecological Incidents

A preliminary review on May 17, 2016 of the Ecological Incident Information System (EIIS, version 2.1.1), which is maintained by the Agency's Office of Pesticide Programs and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 178 reported ecological incidents in the United States associated with the use of the dicamba acid and salt active ingredients (summarized by certainty in **Table 18**). This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents

classified as ‘unlikely’ the result of or ‘unrelated’ to dicamba will not be included in this Problem Formulation or the ecological risk assessment conducted for Registration Review.

All of the dicamba incidents in these databases, excluding those classified as ‘unlikely’ or ‘unrelated’, occurred between 1991 and 2013. Six (3%) of the dicamba incidents involved aquatic animals, one (<1%) involved terrestrial animals and 171 (96%) involved plants. The certainty categories regarding the likelihood that the use of dicamba caused the 178 incidents ranged from unlikely (9 incidents), possible (104 incidents), probable (69 incidents) to highly probable (5 incidents). 53 of the incidents were considered registered uses at the time of the incident, 43 involved misuses, and the legality of the use was undetermined in 82 incidents.

EPA is also aware of additional recent incident information (2012—2015), that has not yet been included in EIIS, relating to the use of dicamba on dicamba-tolerant soybean and cotton crops. Information relating to the current knowledge and understanding surrounding these incidents is described in the Section 3 New Use assessment for dicamba on dicamba-tolerant cotton (D404823; USEPA, 2016a) and the addendum to Section 3 New Use assessment for dicamba on dicamba-tolerant soybean (D426789, USEPA, 2016b)

Table 18. Incidents found in the Ecological Incident Information System across all salts and dicamba acid

Incident Type	Use Type	Certainty				
		All (excluding unlikely)	Unlikely	Possible	Probable	Highly Probable
Fish	Misuse	0	0	0	0	0
	Registered Use	1	0	1	0	0
	Undetermined	5	1	5	0	0
Wildlife	Misuse	0	0	0	0	0
	Registered Use	0	0	0	0	0
	Undetermined	1	2	1	0	0
Plants	Misuse	43	1	18	21	4
	Registered Use	52	2	19	33	0
	Undetermined	76	3	60	15	1
Total		178	9	104	69	5

In addition to the incidents recorded in EIIS and AIMS, additional incidents have been reported to the Agency in aggregated incident reports. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as ‘minor fish and wildlife’ (W-B), ‘minor plant’ (P-B), and ‘other non-target’ (ONT) incidents. ‘Other non-target’

incidents include reports of adverse effects to insects and other terrestrial invertebrates. For dicamba, registrants have reported 24 minor fish and wildlife incidents, 8340 minor plant incidents, and 3 other non-target incidents. Unless additional information on these aggregated incidents become available, they will be assumed to be representative of registered uses of dicamba in the risk assessment.

7. Exposure Pathways of Concern

The environmental fate properties and use patterns of dicamba indicate that direct spray onto food residues, spray drift, leaching to ground water, volatilization, and runoff represent potential transport mechanisms of dicamba to aquatic and terrestrial organisms.

Drinking water and inhalation exposure pathways were screened using the SIP (Screening Imbibition Program) and STIR (Screening Tool for Inhalation Risk) screening methods. Drinking water with dicamba or DCSA residues was found to be a potential exposure pathway of concern (LOC exceedances are expected) on an acute and chronic basis for birds and mammals. SIP and STIR are described in detail at: <http://www.epa.gov/oppefed1/models/terrestrial/index.htm>.

The Screening Tool for Inhalation Risk (STIR v.1.0) was used to assess the potential for risk to birds and mammals through inhalation exposure. The exposure pathways that are assessed by this tool include both droplet inhalation and vapor-phase inhalation. STIR, used in the problem formulation phase, is intended to determine if exposure is likely and not whether the potential for risk exists based on a chemical's maximum application rate, molecular weight and vapor pressure and the available mammalian acute oral and inhalation toxicity endpoints and avian acute oral endpoint (an adjusted avian inhalation toxicity endpoint is estimated from the mammalian toxicity data). If STIR predicts that exposure is likely, additional inhalation data may be necessary to adequately assess risk due to the inhalation exposure pathway. Based on STIR screening analysis, inhalation is not considered likely to be a significant route of exposure for birds and mammals from vapor exposure, but for birds could potentially be a significant route of exposure where applications are greater than 2.1 lbs a.e./A. However, this concern is based on the assumption that the highest test concentration from the available mammalian inhalation toxicity test (5.3 mg/L) results in 50% mortality, but as this is a non-definitive (>) endpoint, it is likely highly conservative. Given that few maximum dicamba application rates are greater than 2.1 lbs a.e./A, and the mammalian inhalation endpoint was non-definitive and therefore is likely highly conservative, no additional inhalation data is requested. See **Appendix B** for STIR inputs and outputs.

The Screening Imbibition Program (SIP 1.0, Released June 15, 2010) was used to calculate an upper bound estimate of exposure using dicamba's and DCSA's solubility in water (6100 mg/L for dicamba, 2112 mg/L for DCSA), the most sensitive acute and chronic avian toxicity endpoints (bobwhite acute LD₅₀ of 188 mg/kg-bw, mallard NOAEC of 695 mg/kg-diet) and the most sensitive acute and chronic mammalian toxicity endpoints (male laboratory rat acute LD₅₀ of 2740 mg/kg-bw and rat chronic NOAEL of 136 mg/kg-bw for dicamba, acute and chronic rat endpoints of 2641 mg/kg-bw and 8 mg/kg-bw for DCSA). Drinking water exposure alone to either dicamba or DCSA residues was determined to be a potential pathway of concern for

mammalian and avian species on both an acute and chronic basis. This pathway will be explored further with the development of SIP v.2.0 in the Ecological Risk Assessment for dicamba. The chronic avian data for DCSA expected to be requested in the DCI will also be used in this assessment of drinking water exposure. For a sample of the output generated by SIP v.1.0, please see **Appendix B**. Detailed information about the SIP v.1.0, as well as the tool, can be found on the EPA's website at http://www.epa.gov/pesticides/science/models_pg.htm#terrestrial.

8. Analysis Plan

8.1. Stressors of Concern

8.1.1. Ecological Risk Assessment

The stressors of concern are parent dicamba (as the acid, salts and esters) and the degradate 3,6-DCSA (dichlorosalicylic acid).

8.1.2. Drinking Water – Human Health

The drinking water assessments conducted to support the registration review human health risk assessments of dicamba will address the parent compound only as acid equivalents across the various formulations, in surface and ground waters. The degradate, 3,6-DCSA will be assessed separately.

8.2. Measures of Exposure

EFED will use standard available models to evaluate potential exposures to aquatic and terrestrial organisms as described at http://www.epa.gov/pesticides/science/models_db.htm.

Available Monitoring Data

The USGS Water Quality Portal (<http://waterqualitydata.us/portal/>) was queried on 05/18/16 for monitoring data using the search term “dicamba.” 50,458 records were returned for water and sediment analyses primarily from the STORET and NWIS databases. The vast majority of these records appeared to be “non-detect” or “below reporting limit” for dicamba, as expected. An analysis of these data will be done in the risk assessment.

Aquatic Exposure Modeling

The models used to predict aquatic estimated environmental concentrations (EECs) is the Pesticides in Water Calculator (PWC) which incorporates PRZM and the Variable Volume Water Model (VVWM) for surface water and PRZM-GW for ground water. These are publicly available at: <http://www.epa.gov/oppefed1/models/water/index.htm>. Modeling will be conducted using the acid equivalent approach, plus a Total Toxic Residue including 3,6-DCSA if needed.

Terrestrial Exposure Modeling

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX model (version 1.5.2, March 2012). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenaga 1972). The Fletcher *et al.* (1994) modifications to the Kenaga nomograph are based on measured field residues from 249 published research papers, including information on 118 species of plants, 121 pesticides, and 17 chemical classes.

In recent risk assessments (USEPA, 2016a-b), EFED has used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value of **8.4 days**, which will be used in the registration review risk assessment.

Screening level calculations have suggested that the drinking water exposure pathway may be a significant concern for birds and mammals and will be further evaluated at the time of risk assessment with SIP v2.0.

EECs for terrestrial plants inhabiting dry and wetland areas are derived using TerrPlant (version 1.2.2, December 2006). This model uses estimates of pesticides in runoff and in spray drift to calculate EECs. EECs are based upon solubility, application rate and minimum incorporation depth in addition to type of formulation and method of application. The Agency is currently developing a replacement model for TerrPlant. If the replacement has been approved prior to the initiation of the risk assessment, this new model will be used instead.

Two spray drift models, AgDisp and AgDRIFT, are used to assess exposures of aquatic and terrestrial organisms to dicamba deposited in terrestrial and aquatic habitats by spray drift. AgDRIFT (version 2.1.1; dated 12/29/2011) is the model most commonly used to simulate spray drift into terrestrial and aquatic environments from aerial and ground applications. AgDisp (version 8.13; dated 12/14/2004) (Teske and Curbishley, 2003) is used when a parameter needs to be modeled that is not available in AgDRIFT. Spray drift analysis will be an important part of the analysis in defining the potential area of effects to non-target species.

8.3. Measures of Effect

Toxicity data presented in Section 6 of this problem formulation will be used to calculate risk quotients. Any additional information submitted by the registrant or found in the open literature prior to conduct of the risk assessment will also be considered. The open literature studies are identified using EPA's ECOTOXicology database (ECOTOX) (USEPA, 2009), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of both sources of data can also provide insight into the direct and indirect effects of pesticides on biotic communities from loss of species that are sensitive to the chemicals and from changes in structure and functional characteristics of the affected communities.

9. Endangered Species Assessments

Consistent with the Agency's responsibility under the Endangered Species Act (ESA), the Agency will evaluate risks to federally listed threatened and/or endangered (listed) species from registered uses of pesticides in registration review. The process for evaluating potential risks to listed species is further described at <https://www.epa.gov/endangered-species>. Three endangered species assessments were recently conducted for the post-emergent use of dicamba DGA salt on dicamba-tolerant soybean and cotton (USEPA, 2016c-e. D416416+, D422305, D425049) covering listed species in 34 states.

10. Endocrine Disruptor Screening Program

As required by FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of the Preliminary Problem Formulation for Registration Review (DP Barcode 426710), EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), dicamba is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2

testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013^[1] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. Dicamba is not on either the first or second list. For further information on the status of the EDSP, the policies and procedures, the initial list of 67 chemicals or the overview of the second list of 109 chemicals, the test guidelines and the Tier 1 screening battery, please visit our website: <http://www.epa.gov/endo/>.

11. Preliminary Identification of Data Gaps

11.1. Environmental Fate

Table 19 identifies environmental fate studies by MRID that offer data for each guideline requirement, as well as study classifications and whether or not further data are needed in order to support risk assessment.

Table 19. Submitted Environmental Fate Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Comments, Justification and Assumptions EPA will Make in Absence of Data
835.2120	Hydrolysis	40547902 40335501 43245208	Acceptable	No	
835.2240	Aqueous photolysis	42774102	Acceptable	No	
835.2410	Soil photolysis	42774103	Acceptable	No	
835.4100	Aerobic Soil Metabolism	43245207 49067702 48718002	Acceptable Supplemental Supplemental	Yes	(One US soil) (Two European soils) (Four US soils) Acceptable data on more than one US soil is requested
835.4200	Anaerobic soil metabolism	40547906 43245208	Acceptable	No	
835.4300	Aerobic aquatic metabolism	43758509	Supplemental	Yes	Acceptable data on more than one system is requested.
835.4400	Anaerobic aquatic metabolism	43245208	Acceptable	No	

^[1] See <http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074> for the final second list of chemicals.

OCSPP Guideline	Data Requirement	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Comments, Justification and Assumptions EPA will Make in Absence of Data
835.1230 835.1240	Adsorption/desorption and leaching	42774101 43095301 (DCSA)	Acceptable Supplemental	No	
835.6100	Terrestrial field dissipation	40547908 42754101 42754102 42754103 44373708 48718005 43361506 43361507 43651405 43651407 43651408	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental	No	K salt K salt Na and DGA salts DGA salt DMA salt DGA salt Na salt
835.1410	Laboratory Volatility	41966602	Acceptable	Yes	Study is for dicamba K salt. Data on all formulations proposed for use on dicamba-tolerant crops required.
835.8100	Field Volatility	49022501 49067704	Supplemental Pending	Yes	Requested for each registered salt and ester formulation intended for use on dicamba-tolerant crops.
840.1100	Spray Drift Droplet Spectrum	49671601 49671602 49067704	Pending	Yes	Requested for each formulation intended for use on dicamba-tolerant crops.
840.1200	Spray Drift Field Deposition	49770301	Pending	Yes	Requested for each formulation intended for use on dicamba-tolerant crops.
850.1730	Fish BCF	--	Waived	No	Bioconcentration in fish is not expected based on dicamba's solubility and pKa.
850.6100	Water and Soil Environmental Chemistry Methods			Yes	
850.6100	Soil and Water Independent Laboratory Validation			Yes	
835.6100	Foliar dissipation			Yes	Data are needed for parent dicamba and for DCSA

11.2. Effects

Table 20 and **Table 21** identify ecological effects studies by MRID that offer data for each guideline requirement, as well as study classifications and whether or not further data are needed in order to support risk assessment.

Table 20. Submitted Aquatic Ecological Effects Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Current Additional Data Need
850.1010	Freshwater invertebrate acute toxicity	029801	40098001	Supplemental--Quantitative	No	--
		029802	00028283	Acceptable	No	
		029806	00085935	Acceptable	No	
		128931	00162069	Supplemental—Quantitative	No	
		128944	00265442	Supplemental--Quantitative	No	
		129043	00258983	Supplemental—Qualitative	No	
850.1025 850.1035 850.1045 850.1055	Saltwater invertebrate acute toxicity	029801	00034702	Acceptable	No	No data are available for dicamba's toxicity to estuarine/marine mollusks. Data following the 850.1025 (shell deposition) guideline should be submitted using TGAI dicamba acid.
		029801	No Data	N/A	Yes	
850.1075	Freshwater fish acute toxicity	029801	40098001	Supplemental--Quantitative	No	--
		029802	00263000 00046183 00046184	Acceptable	No	
		029806	00029623	Acceptable	No	
		128931	00162068 00162067	Acceptable	No	
		128944	00265440 00265441	Acceptable	No	
		129043	Acc# 00258932	Supplemental—Quantitative	No	
850.1075	Saltwater fish acute toxicity	029801	00025390	Acceptable	No	--
850.1300	Freshwater invertebrate life cycle	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to freshwater invertebrates. A freshwater invertebrate life cycle study should be submitted using a species for which acute data is available using TGAI dicamba acid. Additionally, due to empirical mammalian data and predicted chronic toxicity to aquatic invertebrates, chronic daphnid data should be submitted for DCSA.
		Metabolite DCSA	No Data	N/A	Yes	

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Current Additional Data Need
850.1350	Saltwater invertebrates life cycle	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to saltwater invertebrates. A saltwater invertebrate life cycle study should be submitted using a species for which acute data is available using TGAI dicamba acid.
850.1400	Freshwater fish early-life stage	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to freshwater fish. A freshwater fish early life stage study should be submitted using a species for which acute data is available using TGAI dicamba acid. Additionally, due to empirical mammalian data and predicted chronic toxicity to fish, chronic fish data should be submitted for DCSA with the same fish species used to fulfill the 850.1400 guideline with dicamba acid.
		Metabolite DCSA	No Data	N/A	Yes	
850.1400	Saltwater fish early-life stage	029801	No Data	N/A	No	No data are available for chronic effects of dicamba to saltwater fish. A saltwater fish early life stage study should be submitted using a species for which acute data is available using TGAI dicamba acid
850.1500	Fish life cycle	029801	No Data	N/A	No	--
850.4400	Aquatic plant Toxicity Test using Lemna spp.	029801	42774111	Invalid	Yes	Conditions in controls of the submitted study were inadequate to represent typical environmental conditions and may have adversely impacted control performance. A new study is needed using TGAI dicamba acid.
850.4500	Algal toxicity	029801	42774110	Acceptable	No	--
		029801	42774107	Acceptable	No	
		029801	42774108	Acceptable	No	
850.4550	Cyanobacteria	029801	42774109	Acceptable	No	--

Table 21. Submitted Terrestrial Ecological Effects Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assess- ment?	Current Additional Data Need
850.2100	Avian oral toxicity	029801	42774106 42774105	Acceptable	Yes	A passerine acute oral study is required as dicamba is moderately toxic on an acute basis to bobwhite quail and passerine species may be more sensitive than other taxa.
		029801	No Data	N/A		
		029802	00073275 00046180	Acceptable		
		128931	00263863	Invalid		
		129043	00261466	Supplemental-- Quantitative		
850.2200	Avian dietary toxicity	029801	42918001 42774105	Acceptable	No	--
		029802	00034693 00022527	Acceptable		
		029806	00068785	Acceptable		
		128931	00162071 00162072	Acceptable		
		129043	00261465 00261466	Supplemental-- Quantitative		
850.2300	Avian reproduction	029801	43814003	Acceptable	No	Chronic avian data (mallard duck preferred) with the metabolite DCSA is needed for the risk assessment. In the absence of chronic data, EPA will consider alternative approaches (<i>i.e.</i> using the difference between the chronic mammalian studies with dicamba and DCSA and comparing to the chronic mallard endpoint with dicamba acid.)
		Metabolite DCSA	No Data	N/A	Yes	
850.3020	Honey bee acute contact toxicity (Tier 1)	029801	00036935	Supplemental— Quantitative	No	--

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.3030	Honey bee residue on foliage (Tier 1)	029801	No Data	N/A	No	Data have not been submitted to fulfill this guideline. A data gap was not identified as these data are not necessary for risk assessment at this time since dicamba's acute contact LD ₅₀ was greater than the trigger of 11 µg/bee.
Non-guideline	Honey bee adult acute oral toxicity (Tier 1)	029801	No Data	N/A	Yes	No data is available assessing the oral exposure route for terrestrial invertebrates. A study should be submitted using TGAI dicamba acid. Although EPA has not developed a guideline for this study, OECD TG 213 may be used to satisfy the guideline requirement.
Non-guideline	Honey bee adult chronic oral toxicity (Tier 1)	029801	No Data	N/A	Yes	No data is available assessing the oral exposure route for terrestrial invertebrates. A study should be submitted using TGAI dicamba acid. Neither EPA nor OECD have an approved guideline for this study, but draft OECD guidance is in development. A protocol should be submitted prior to study initiation.
Non-guideline	Honey bee larval acute oral toxicity (Tier 1)	029801	No Data	N/A	Yes	In addition to the adult honey bee data gaps identified above, data is needed for the additional

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
Non-guideline	Honey bee larval chronic oral toxicity (Tier 1)	029801	No Data	N/A	Yes	honey bee life stage of larvae to complete the risk assessment for pollinators. Although EPA has not developed a guideline for these studies, OECD TG237 may be used to assess acute oral effects on larvae. Chronic (repeat dose) study guidance for assessing chronic oral toxicity to honey bee larvae is currently in development by OECD. A protocol should be submitted prior to study initiation.
Non-guideline	Magnitude of Residues in Pollen and Nectar	029801	No Data	N/A	Yes	Data have not been submitted to fulfill this guideline. Results from lower tier studies should inform the conduct of the field test to address remaining uncertainties. Pending the results of lower tier studies (adult honey bee acute oral, chronic adult honey bee, acute and chronic larval), magnitude of residue studies may not be needed to complete the risk assessment for pollinators. A protocol should be submitted prior to test initiation.

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.3040	Field testing for pollinators (Tier 2)	029801	No Data	N/A	Yes	Data have not been submitted to fulfill this guideline. Results from lower tier studies should inform the conduct of the field test to address remaining uncertainties. Pending the results of lower tier studies (adult honey bee acute oral, chronic adult honey bee, acute and chronic larval), a field testing study may not be needed to complete the risk assessment for pollinators. A protocol should be submitted prior to test initiation.
850.4100	Seedling Emergence and Seedling Growth	029801	42846301	Supplemental--Qualitative	Yes	The submitted data for dicamba acid were with TGAI and were conducted on plants grown in pure sand. New data are needed for representative TEP for dicamba acid using the standard suite of 10 species.
		029802	No Data	N/A	No	
		029803	No Data	N/A	No	
		029806	No Data	N/A	No	
		128931	47815101	Acceptable	No	
		128944	No Data	N/A	No	
		129043	No Data	N/A	No	
850.4150	Vegetative Vigor	029801	42846301	Supplemental--Qualitative	Yes	The submitted data for dicamba acid were with TGAI and were conducted on plants grown in pure sand. New data are needed for representative TEP for dicamba acid and all salts (except for DGA-salt), with 7 species (onion + 6 dicot species).
		029802	No Data	N/A	Yes	
		029803	No Data	N/A	Yes	
		029806	No Data	N/A	Yes	
		128944	No Data	N/A	Yes	
		129043	No Data	N/A	Yes	

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
		128931	47814102	Supplemental—Quantitative	Yes ¹	¹ For DGA-salt, acceptable data is available for all species except for lettuce, for which data is still needed.

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USEPA, 2016e. Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 11 U.S. States: (Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia). D425049. Environmental Fate and Effects Division, Office of Pesticide Programs, Office of Chemical Safety and Pollution Prevention. Washington, DC. March 24, 2016

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Appendix A. Maximum Use Rate Information for Dicamba and its Associated Salts

Table A1. Maximum Labeled Use Rate Information for Dicamba Acid (PC Code 029801)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
GRASS (GROWN FOR SEED)	1.52	2.95	NS	NS	Broadcast
GRASS (FORAGE/FODDER/HAY), PASTURES, RANGELAND	1.50	3.01	2	30 day	Spot treatment
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE, AGRICULTURAL UNCULTIVATED AREAS	1.5	1.88	2	NS	Spot treatment, banded, broadcast (aerial, sprayer)
SOYBEANS	1.47	2.95	NS	NS	Broadcast, Spot Treatment
SUGARCANE	1.47	2.95	NS	NS	Broadcast (aerial, sprayer), banded, spot treatment, Wipe-on
ORNAMENTAL LAWNS & TURF, SOD FARMS	1.47	1.47	NS	30 day	Broadcast (aerial, sprayer), spot treatment, wipe-on
FOREST TREE MANAGEMENT/FOREST PEST MANAGEMENT	1.03	1.03	1	N/A	Broadcast (aerial & ground), Spot Treatment
CORN	0.74	1.10	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
ASPARAGUS	0.74	0.74	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
SORGHUM, WHEAT	0.37	0.74	NS	NS	Banded, Spot Treatment, Broadcast (aerial, sprayer)
BARLEY	0.37	0.55	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
COTTON	0.37	0.37	NS	NS	Broadcast (aerial, sprayer), banded, spot treatment
OATS, PROSO MILLET, TRITICALE	0.18	0.18	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
GOLF COURSE, RECREATION & RESIDENTIAL LAWNS	0.12	0.24	2	30 day	Broadcast (spreader)

NS-Not Specified

Table A2. Maximum Labeled Use Rate Information for Dicamba DMA salt (PC Code 029802)

Use Site	Maximum Rate (lbs a.e./Acre)		Max. No. of Apps/Year	Min. App. Interval	Application Methods/Comments
	Single	Annual			
NONAGRICULTURAL UNCULTIVATED AREAS/SOILS, AGRICULTURAL/FARM PREMISES, PASTURES, RANGELAND	2.42	2.42	NS	NS	Spot treatment
HAY (SILAGE)	2.42	2.42	NS	NS	Banded, spot treatment
SUGARCANE	2.42	2.42	NS	NS	Banded, Broadcast (aerial & ground), spot treatment, wipe-on
ORNAMENTAL SOD FARM (TURF)	2.35	2.35	NS	NS	Spot treatment
ORNAMENTAL LAWNS AND TURF	2.00	NS	2	30 days	Cut stem treatment
NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS	1.65	1.65	1	30 days	Spot treatment
AGRICULTURAL CROPS/SOILS (UNSPECIFIED), AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.21	2.42	NS	NS	Spot treatment, Broadcast (aerial, ground), Wipe-on.
GRASSES GROWN FOR SEED	1.21	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
GRASS FORAGE/FODDER/HAY	0.83	1.65	2	30 days	Spot treatment
CORN	0.60	0.91	NS	14 days	Banded, Broadcast (aerial, ground), Spot treatment, Wipe-on
ASPARAGUS	0.60	0.60	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
WHEAT	0.53 or 0.15	0.74 or 2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground). Max 2.42 lb/A annual rate is only for the lower max application rate (0.15 lb/A single)

Use Site	Maximum Rate (lbs a.e./Acre)		Max. No. of Apps/Year	Min. App. Interval	Application Methods/Comments
	Single	Annual			
HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES, ORNAMENTALS, PATHS/PATIOS, PAVED AREAS (PRIVATE ROADS/SIDEWALKS)	0.49	NS	2	NS	Spot treatment, Spot soil treatment
SORGHUM	0.42	NS	1	N/A	Banded, Spot treatment, Broadcast (aerial, ground)
SORGHUM	0.30	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground)
COTTON	0.30	NS	2	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
RECREATIONAL AREAS/LAWNS	0.22	NS	2	30 days	Broadcast (spreader)
GOLF COURSE TURF	0.19	NS	2	30 days	Spot treatment
BARLEY, OATS	0.15	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
TRITICALE	0.15	NS	2	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
COMMERCIAL/INDUSTRIAL LAWNS	0.09	NS	2	30 days	Spot treatment, broadcast (ground)

NS-Not Specified

Table A3. Maximum Labeled Use Rate Information for Dicamba DEA-salt (PC Code 0291803)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
SOYBEANS	1.00	NS	2	30 days	Spot treatment

Table A4. Maximum Labeled Use Rate Information for Dicamba Na-salt (PC Code 0291806)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
GRASSES GROWN FOR SEED	2.21	NS	NS	NS	Broadcast (aerial, ground)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.25	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SOYBEANS, SUGARCANE	1.25	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment
AGRICULTURAL/FARM PREMISES, HAY (SILAGE), NONAGRICULTURAL UNCULTIVATED AREAS/SOILS, ORNAMENTAL SOD FARM (TURF), PASTURES, RANGELAND,	1.25	1.25	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SMALL GRAINS	1.10	2.21	NS	NS	Broadcast (aerial, ground)
CORN	0.63	0.89	NS	14 days	Banded, Broadcast (aerial, ground), Wipe-on
ASPARAGUS	0.63	0.63	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded, Wipe-on
WHEAT	0.63	0.63	NS	NS	Wipe-on treatment
COTTON	0.31	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SORGHUM	0.31	0.63	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
BARLEY	0.31	0.44	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
GRASS FORAGE/FODDER/HAY	0.28	0.28	NS	NS	Broadcast (ground), Spot treatment
OATS, TRITICALE	0.16	0.16	NS	NS	Banded, Broadcast (aerial, ground), Spot treatment, Wipe-on
PROSO MILLET	0.14	0.14	NS	NS	Broadcast (aerial, ground)

Table A5. Maximum Labeled Use Rate Information for Dicamba DGA-salt (PC Code128931)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS, PASTURES,	3.05	3.05	NS	NS	Spot Treatment, Broadcast (aerial, ground), Banded, Wipe-on, Soil treatment, Spot soil

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
RANGELAND, SUGARCANE					
FOREST TREES (ALL OR UNSPECIFIED)	2.95	2.95	NS	NS	Broadcast (aerial, ground)
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.53	3.05	NS	NS	Spot Treatment, Broadcast (aerial, ground), Wipe-on, Banded, Spot soil treatment
GRASSES GROWN FOR SEED	1.53	3.05	NS	NS	Banded (ground), Spot Treatment, Broadcast (aerial, ground), Wipe-on
SOYBEANS	1.53	3.05	NS	NS	Banded, Spot Treatment, Broadcast (aerial, ground)
GOLF COURSE TURF	1.53	2.95	NS	NS	Broadcast (aerial, ground), Spot treatment (aerial, ground)
GRASS FORAGE/FODDER/HAY,	1.53	2.90	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded, Wipe-on, Basal bark treatment, Spot soil
ORNAMENTAL LAWNS AND TURF, ORNAMENTAL SOD FARM (TURF)	1.53	2.95	NS	30 days	Banded (aerial, ground), broadcast (aerial, ground), spot treatment, wipe-on
CORN, COTTON	1.48	2.98	NS	NS	Broadcast (aerial, ground), spot treatment, wipe-on, Banded
AGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/H EDGEROWS, INDUSTRIAL / CONSTRUCTION AREAS (OUTDOOR)	1.48	2.95	NS	NS	Low volume spray (concentrate), high volume spray (dilute), Broadcast (aerial), Spot treatment
RECREATIONA AREA LAWNS	1.48	2.95	NS	30 days	Broadcast (aerial, ground)
ASPARAGUS	0.76	0.76	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded (ground), Wipe-on
SMALL GRAINS	0.76	NS	NS	NS	Broadcast (aerial, ground), Spot treatment, Wipe-on, Banded
SORGHUM	0.38	2.98	NS	NS	Banded, Broadcast (aerial, ground), Spot treatment
WHEAT	0.38	0.76	NS	NS	Broadcast (aerial, ground), Spot treatment, Wipe-on, Banded
BARLEY	0.38	0.57	NS	NS	Broadcast (aerial, ground), Spot treatment (aerial, ground), Banded, Wipe-on
OATS, TRITICALE	0.19	0.19	NS	NS	Banded (aerial, ground), Broadcast (aerial, ground), Spot treatment, Wipe-on

Table A6. Maximum Labeled Use Rate Information for Dicamba IPA-salt (PC Code 128944)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
COTTON	1.28	1.60	NS	NS	Broadcast (aerial, sprayer), Spot treatment
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	0.35	0.35	NS	NS	Broadcast (aerial, ground), Spot treatment (ground), Spray (aerial, ground)
CORN	0.32	NS	2	14 days	Broadcast (aerial, sprayer), Directed spray, Spray (aerial, ground), Spot treatment
SMALL GRAINS	0.26	NS	NS	NS	Broadcast (aerial, sprayer), Spot treatment
WHEAT	0.23	NS	2	30 days	Spray (aerial, ground), low volume spray—concentrate (aerial, ground), Spot treatment
AGRICULTURAL/FARM PREMISES, FENCEROWS/HEDGE ROWS	0.22	NS	2	NS	Broadcast (ground)
BARLEY	0.22	NS	NS	NS	Spray (aerial, ground), Low volume spray—concentrate (aerial, ground)
OATS	0.16	NS	2	30 days	Spray (aerial, ground), low volume spray—concentrate (aerial, ground), Spot treatment
SORGHUM	0.16	NS	2	30 days	Spray (aerial, ground), litter and bedding treatment, Low volume—concentrate (ground)
PASTURES, RANGELAND	0.11	NS	2	30 days	Broadcast (aerial, ground), Spot treatment
NONAGRICULTURAL RIGHTS-OF-WAY, NONAGRICULTURAL UNCULTIVATED AREAS/SOILS	0.07	NS	NS	NS	Broadcast (ground)

Appendix B- SIP and STIR Outputs

SIP—Dicamba

Table 1. Inputs

Parameter	Value
Chemical name	Dicamba
Solubility (in water at 25°C; mg/L)	6100
Mammalian LD ₅₀ (mg/kg-bw)	2740
Mammalian test species	laboratory rat
Body weight (g) of "other" mammalian species	
Mammalian NOAEL (mg/kg-bw)	136
Mammalian test species	laboratory rat
Body weight (g) of "other" mammalian species	
Avian LD ₅₀ (mg/kg-bw)	188
Avian test species	northern bobwhite quail
Body weight (g) of "other" avian species	
Mineau scaling factor	1.15
Mallard NOAEC (mg/kg-diet)	695
Bobwhite quail NOAEC (mg/kg-diet)	1390
NOAEC (mg/kg-diet) for other bird species	
Body weight (g) of other avian species	
NOAEC (mg/kg-diet) for 2nd other bird species	
Body weight (g) of 2nd other avian species	

Table 2. Mammalian Results

Parameter	Acute	Chronic
Upper bound exposure (mg/kg-bw)	1049.2000	1049.2000
Adjusted toxicity value (mg/kg-bw)	2107.5000	104.6058
Ratio of exposure to toxicity	0.4978	10.0300
Conclusion*	Exposure through drinking water alone is a potential concern for mammals	Exposure through drinking water alone is a potential concern for mammals

Table 3. Avian Results

Parameter	Acute	Chronic
Upper bound exposure (mg/kg-bw)	4941.0000	4941.0000
Adjusted toxicity value (mg/kg-bw)	135.4407	34.4807
Ratio of exposure to acute toxicity	36.4809	143.2974
Conclusion*	Exposure through drinking water alone is a potential concern for birds	Exposure through drinking water alone is a potential concern for birds

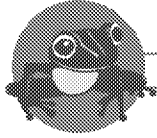
*Conclusion is for drinking water exposure alone. This does not combine all routes of exposure. Therefore, when aggregated with other routes (*i.e.*, diet, inhalation, dermal), pesticide exposure through drinking water may contribute to a total exposure that has potential for effects to non-target animals.

Table 3. STIR Inputs and Outputs

Input		
Application and Chemical Information		
Enter Chemical Name	Dicamba	
Enter Chemical Use	Reg Review (many)	

Is the Application a Spray? (enter y or n)	y		
If Spray What Type (enter ground or air)	air		
Enter Chemical Molecular Weight (g/mole)	221		
Enter Chemical Vapor Pressure (mmHg)	3.41E-05		
Enter Application Rate (lb a.i./acre)	3.05		
Toxicity Properties			
Bird			
Enter Lowest Bird Oral LD ₅₀ (mg/kg bw)	188		
Enter Mineau Scaling Factor	1.15		
Enter Tested Bird Weight (kg)	0.178		
Mammal			
Enter Lowest Rat Oral LD ₅₀ (mg/kg bw)	2740		
Enter Lowest Rat Inhalation LC ₅₀ (mg/L)	5.3		
Duration of Rat Inhalation Study (hrs)	4		
Enter Rat Weight (kg)	0.35		
Output			
Results Avian (0.020 kg)			
Maximum Vapor Concentration in Air at Saturation (mg/m ³)	4.06E-01	Exposure not Likely Significant	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	5.10E-02		
Adjusted Inhalation LD ₅₀	2.03E+00		
Ratio of Vapor Dose to Adjusted Inhalation LD ₅₀	2.51E-02		
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	2.93E-01		
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD ₅₀	1.45E-01	Proceed to Refinements	
Results Mammalian (0.015 kg)			

Maximum Vapor Concentration in Air at Saturation (mg/m ³)	4.06E-01	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	6.41E-02	
Adjusted Inhalation LD ₅₀	3.16E+02	
Ratio of Vapor Dose to Adjusted Inhalation LD ₅₀	2.03E-04	Exposure not Likely Significant
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	3.68E-01	
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD ₅₀	1.17E-03	Exposure not Likely Significant



September 12, 2016

Office of Pesticide Programs
Environmental Protection Agency Docket Center (EPA/DC)
EPA West Building, Room 3334
1301 Constitution Ave NW
Washington, DC 20460-0001

**Re: Comments on EPA Opening the Registration Review Docket – Dicamba
(Docket #: EPA-HQ-OPP-2016-0223)**

Please accept the following comments on behalf of the Center for Biological Diversity (“Center”) in response to the Environmental Protection Agency’s (“EPA”) opening the registration review docket for dicamba under the Federal Insecticide, Fungicide, and Rodenticide Act (“FIFRA”). The Center previously submitted comments on a new use of dicamba on herbicide-tolerant cotton and soybean (Docket #: EPA-HQ-OPP-2016-0187) and incorporates those comments by reference.

The Center for Biological Diversity (“Center”) is a non-profit environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has more than one million members and online activists dedicated to the protection and restoration of endangered species and wild places. The Center has worked for twenty-six years to protect imperiled plants and wildlife, open space, air and water quality, and overall quality of life. The Center’s Environmental Health Program aims to secure programmatic changes in the pesticide registration process and to stop toxic pesticides from contaminating fish and wildlife habitats. We appreciate the opportunity to provide comment.

Before the EPA can make a supportable decision to authorize additional uses of this pesticide, it must first accomplish all of the following:

1. Comply with duties under Section 7 of the Endangered Species Act (ESA),¹ including completion of consultation.

As a separate, discretionary action that may affect endangered and threatened species, the EPA cannot approve new uses prior to the completion of consultations with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (“the Services”). Without such consultation, the EPA cannot satisfy its duty to insure that its action does not jeopardize the continued existence of imperiled species across the country or adversely modify or destroy their critical habitat. Moreover, unless and until the EPA completes ESA consultation, any taking of protected species from the use of this pesticide is unlawful.

Section 7(a)(2) of the Endangered Species Act (“ESA”) requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary . . . to be critical.”² Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.³ Indeed, the EPA’s recently finalized policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.⁴ The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.⁵ The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement.”⁶ Accordingly, the EPA must consult with the Services on its continuing and ongoing authority over this pesticide to satisfy its duty to insure that its use will not jeopardize or adversely modify protected species or their critical habitat well *before* it proposes a registration review decision. *See* Endangered Species Act Consultation Obligations for Pesticide Approvals by the Environmental Protection Agency (enclosed).

The EPA must consult on all synergistic and cumulative uses. The EPA must insure that all uses of this pesticide do not jeopardize species protected by the ESA or adversely modify or destroy their critical habitat, including uses with other ingredients or other pesticides. Absent

¹ 16 U.S.C. § 1536.

² 16 U.S.C. § 1536(a)(2) (emphasis added).

³ 50 C.F.R. § 402.14(a).

⁴ http://www.epa.gov/oppfead1/cb/csb_page/updates/2013/esa-regreview.html

⁵ 50 C.F.R. § 402.14(a).

⁶ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

information or data to determine whether dicamba will act synergistically with other ingredients, such uncertainty requires that the EPA decline to re-register any end use products containing more than one active ingredient and prohibit tank mixing on the labels.

At a minimum, where a product may affect listed species, all product labels must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁷

2. Require that that the registrant provide all necessary data and studies.

The EPA must have substantial evidence to re-register this pesticide. To do so, the EPA must require all necessary data and studies, including, but not limited to any previously identified data or study gaps, additional studies to evaluate effects on pollinators in accordance with the *Guidance for Assessing Pesticide Risks to Bees*,⁸ information concerning estrogen or other endocrine disruption effects,⁹ and any information that this pesticide or products containing this pesticide may have synergistic effects.

3. Incorporate necessary factors into evaluation and any proposed decision.

These factors should include the following, at a minimum:

- a. effects on species listed as protected under the ESA and their critical habitat,
- b. effects on pollinators and other beneficial insects,
- c. effects on human health or environmental safety concerning endocrine disruption, and
- d. any additive, cumulative or synergistic effects of the use of this pesticide.

⁷ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

⁸ EPA 2014. *Guidance for Assessing Pesticide Risks to Bees*. Available at https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf

⁹ See 21 U.S.C. §§ 346a(d)(2)(A)(x) and 346a(p).

EPA cannot propose a registration review decision under FIFRA (often described as “interim”) and satisfy its legal duties unless it requires sufficient information and evaluates it for adverse effects before reaching any conclusions.

Congress tasked the EPA with regulation of pesticides for safe use. FIFRA authorizes EPA to register a pesticide only upon determining that the pesticide “will perform its intended function without unreasonable adverse effects on the environment,” and that “when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse effects on the environment.”¹⁰ The statute defines “unreasonable adverse effects on the environment” to include “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.”¹¹ The EPA cannot meet this standard without requiring, evaluating and considering all information that causes adverse effects from the additional use of this pesticide. *Pollinator Stewardship Council v. U.S. E.P.A.*, Case No. 13-72346, Dkt. No. 58-1 at 6, 2015 WL 5255016, *1.

4. Place appropriate restrictions on uses to avoid and minimize adverse effects.

The EPA has broad authority to restrict uses and place strong mitigation language on labels to avoid adverse effects and when there is uncertainty.

5. The EPA Needs to Take Into Account Real-world Scenarios.

The EPA often claims that it is acting conservatively by using the maximum labeled use rates when estimating exposure to plants and animals. These upper-level exposure scenarios, however, do not take into account accidental spills and illegal uses of the pesticide.

A recent survey of farmers in Missouri indicated that less than half -- only 43 percent -- actually read the label each time they use pesticides.¹² Sixteen percent only read the label half the time or less and 1.2 percent have never read the label at all. Pesticide labels also have wind speed requirements that are meant to reduce drift and are used in EPA’s risk assessment process to estimate off-site exposure. Four percent of pesticide applicators never checked the wind speed before application and 40 percent of applicators checked wind speed by looking at trees, a very unreliable form of measurement that is often inaccurate.

Therefore, the ever-present possibility of an accidental spill indicates that this is a reasonably foreseeable event that should be accounted for when estimating peak exposure concentrations. In

¹⁰ 7 U.S.C. § 136a(e)(5)(C), (D); 40 C.F.R. § 152.112(e).

¹¹ 7 U.S.C. § 136(bb).

¹² Randall. July 13th, 2016. State news. *57 percent of those applying pesticides in Missouri do not read label instructions*. Available at: <http://www.kttm.com/57-percent-of-those-applying-pesticides-in-missouri-do-not-read-label-instructions/>.

addition, the small amount of data that are available on label compliance indicate that it is unreasonable to assume that pesticides are always applied in accordance with the label. We feel that when communicating findings to a risk manager, the EPA no longer refer to its use of maximum labeled rates as “conservative” or accurately estimating peak exposures that may occur.

6. The EPA needs to take into account increased use of dicamba in its risk assessments.

The EPA’s risk assessment approach is not designed to analyze risk due to increased total usage of a pesticide compared to current levels. It is simply designed to estimate exposure to a single chemical based on labeled usage rates on specific crops. This exposes one of the great shortcomings in EPA’s risk assessment approach – it is very short sighted. It takes a narrow approach of assessing risk without taking into account the bigger picture of total usage of a particular pesticide or combined usage of multiple pesticides. Therefore, risk is typically underestimated and potential increases in total pesticide usage are not accurately assessed for potential harms.

The EPA recognized this when proposing to register dicamba for use on dicamba-resistant cotton and soy and stated that “[a]lthough the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications.”¹³ And, “[t]hough the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans.”¹⁴

Dicamba use is on the rise and if the EPA approves the “new use” of dicamba on dicamba-tolerant cotton and soybeans it will result in an even greater increase.^{15,16} Monsanto did an

¹³ EPA. Memorandum. Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). Docket ID: EPA-HQ-OPP-2016-0187-0008.

¹⁴ EPA. Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean. Docket ID EPA-HQ-OPP-2016-0187-0016.

¹⁵ EPA. Memorandum. Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 8770 I). Docket ID EPA-HQ-OPP-2016-0187-0005. Page 36.

¹⁶ Mortensen, DA, Egan, JF, Maxwell, BD, Ryan, MR, Smith, RG. Navigating a Critical Juncture for Sustainable Weed Management. *BioScience* (2012) 62 (1): 75-84. doi:10.1525/bio.2012.62.1.12. and Bohnenblust, EW, Vaudo,

analysis on the possible future increase in use of dicamba for USDA when applying for deregulation of genetically engineered (“GE”) dicamba/glyphosate resistant soybean and cotton. Monsanto predicted that annual commercial dicamba use on soybeans would increase from 233,000 pounds in 2011 to 20.5 million pounds at the time of peak (40%) GE crop adoption.¹⁷ This is a nearly 100-fold increase in dicamba usage just on soybean and could be even higher if these GE crops are more widely adopted. Similar projections were made for dicamba use on cotton from 364,000 pounds applied annually in 2011 to 5.2 million pounds at the time of peak (50%) adoption.¹⁸ Assuming peak adoption of dicamba resistant soybean and cotton would occur in the next 3-4 years, the U.S. is looking at a more than 25 million pound increase in dicamba usage for these two crops by 2020.

Although this is likely an underestimate, as crop adoption rates will likely be much higher and current labels actually urge users to spray higher than typical rates to slow weed resistance, it is a starting point for the EPA to begin to analyze the effects of total pesticide load on human and environmental health. This increase in dicamba usage would not likely displace other herbicide use. The EPA needs to view registration decisions as not only a way to analyze the effects of labeled pesticide usage, but also as a way to ensure that total pesticide use does not increase. The EPA could take this into account in the cost-benefit analysis by analyzing the associated costs of labeled pesticide use as well as the costs associated with total pesticide load in the environment.

There are many parallels here with what happened with glyphosate in the 1990’s. In 1993, the EPA re-registered glyphosate with the finding that labeled use of glyphosate would not cause unreasonable adverse effects on the environment. Of course, a couple of years later the widespread adoption of “Roundup Ready” GE crops resulted in an exponential increase in glyphosate use from around 10 million pounds to around 300 million pounds per year in 25 years.¹⁹ This resulted in many unforeseen environmental problems, most notably by playing a large role in the dramatic decline of the Monarch butterfly. The rapid rise in glyphosate has destroyed Monarch habitat across most of the Midwest and the Monarch is currently being considered for a “threatened” listing under the Endangered Species Act. Glyphosate’s affect on the Monarch was not even discussed in the 1993 ERA for glyphosate. But it happened. There are

AD, Egan, JF, Mortensen, DA, Tooker, JF. Effects of the herbicide dicamba on nontarget plants and pollinator visitation. *Environ Toxicol Chem.* (2016) 35(1): 144-51. doi: 10.1002/etc.3169.

¹⁷ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS appendix, Table 4-9 and page 4-16.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁸ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS Appendix, Table 4-12 and page 4-19.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁹ USGS. *U.S. Geological Survey: Pesticide National Synthesis Project, pesticide use maps-glyphosate.* 2014. [Accessed on 09/12/2016]; Available from: https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2014&map=GLYPHOSATE&hilo=L&disp=Glyphosate.

two reasons for this: 1) the glyphosate ERA did not analyze indirect effects, like those on the milkweed plant that the Monarch is completely reliant on and 2) the EPA did not analyze how such a quick increase in total glyphosate usage would affect the environment. In its dicamba analysis, the EPA needs to fix these two shortcomings in its ERA process and accurately analyze how the inevitable increase in dicamba load in the environment, in combination with glyphosate, will affect human health and the environment.

7. The EPA needs to assess the enhanced toxicity of pesticide mixtures.

The EPA has made no mention of whether it intends to finally do a robust mixture analysis in the upcoming registration review docket. It has long been the EPA's policy to not do a mixture analysis because it's just too darn hard. Yet there is never any mention that this decision essentially results in the default assumption that all mixtures involving dicamba have the exact same toxicity as dicamba alone, a completely scientifically-unjustified assumption. The EPA is constantly saying that there are never enough data and that they lack the methodology to do a robust analysis. But the agency completely ignores the fact that by approving so many multi-ingredient formulations and allowing countless numbers of tank mixtures to occur, it is essentially enabling the existence of all of these mixtures without any data whatsoever that it can be done safely. These are not the actions of an agency that is confident in its abilities to protect the health of humans and the environment; these are the actions of an agency that is in way over its head.

The Center for Biological Diversity recently released a report²⁰ analyzing an unconventional new source of much needed data – patent applications. When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant. For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

We conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta). Our key finding was that 69 percent of these products (96 out of 140) had at least one patent application

²⁰ Donley, N. (2016). Toxic Concoctions: How The EPA Ignores The Dangers Of Pesticide Cocktails. Retrieved from The Center for Biological Diversity website: http://www.biologicaldiversity.org/campaigns/pesticides_reduction/pdfs/Toxic_concoctions.pdf. Submitted to the docket with comment letter.

that claimed or demonstrated synergy between the active ingredients in the product.

There were 11 multi-ingredient products containing dicamba that were approved in the past six years from these four companies.²¹ Of those 11, ten have evidence of synergy between the active ingredients in the product. The identified patent applications in our report found synergistic toxicity to plants from the combinations of:

- 1) Dicamba and glyphosate (U.S. patent application numbers 13099552 and 13751021)
- 2) Dicamba and penoxsulam (U.S. patent application number 14026902)
- 3) Dicamba and Isoxaben/indaziflam (U.S. patent application numbers 13841457 and 12506456)

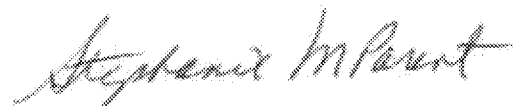
None of these patent applications were discussed in any documents in the docket despite being directly relevant to the analysis at hand. Since most products that contain dicamba were approved more than six years ago, our analysis would not have identified other patent applications or studies that may be relevant to other dicamba products.

This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them.

Therefore, in order to be compliant with FIFRA, the EPA must do an analysis of mixture toxicity with mixtures containing dicamba before a re-registration decision can be made.

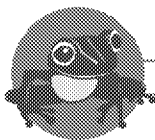
If the EPA does not think that it has the proper methodology in place to do this analysis, prohibiting the co-application of certain pesticides with dicamba through label changes and cancelling certain products that contain these mixtures is another way the EPA can ensure that any registration decision is compliant with FIFRA. Otherwise, the EPA will not be able to conclude that the continued use of dicamba will not have unreasonable adverse effects on the environment.

Respectfully submitted,



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²¹ *Id.* at Appendix B



ENDANGERED SPECIES ACT CONSULTATION OBLIGATIONS FOR PESTICIDE APPROVALS BY THE ENVIRONMENTAL PROTECTION AGENCY

I. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on Pesticide Approvals.

Section 7(a)(2) of the ESA requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary... to be critical.”²² Under Section 7(a)(2), the EPA must consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service (collectively the “Services”) to determine whether its actions will jeopardize listed species’ survival or adversely modify designated critical habitat, and if so, to identify ways to modify the action to avoid that result.²³ The consultation requirement applies to any discretionary agency action that may affect listed species.²⁴ Because the EPA may decline to approve pesticides and uses, its decision represents a discretionary action that clearly falls within the ESA’s consultation requirement.²⁵

The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.²⁶ Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.²⁷ Indeed, the EPA’s policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.²⁸ The Services define “may affect” as “the appropriate conclusion when a proposed action may pose *any* effects on listed species or designated critical habitat.”²⁹ This inquiry even includes beneficial effects. The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character,

²² 16 U.S.C. § 1536(a)(2) (emphasis added).

²³ 50 C.F.R. § 402.14.

²⁴ *National Association of Home Builders v. Defenders of Wildlife*, 551 U.S. 644 (2007).

²⁵ See *Washington Toxics Coalition v. EPA*, 413 F. 3d 1024, 1032 (9th Cir. 2005) (“even though EPA registers pesticides under FIFRA, it must also comply with the ESA when threatened or endangered species are affected.”).

²⁶ 50 C.F.R. § 402.14(a).

²⁷ 50 C.F.R. § 402.14(a).

²⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013) at p. 8

²⁹ U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998, *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* (hereafter CONSULTATION HANDBOOK) at xvi (emphasis in original).

triggers the formal consultation requirement.”³⁰ For this initial stage of review, exposure to a pesticide does not require that effects reach a pre-set level of significance or intensity to trigger the need to consult (e.g. effects do not need to trigger population-level responses). As the Services’ joint consultation handbook explains, an action agency such as the EPA may make a “no effect” determination, and thus avoid undertaking informal or formal consultations, only when “the action agency determines its proposed action will not affect listed species or critical habitat.”³¹

Because the use of these pesticide formulations and products “may affect” listed species and “may affect” the critical habitat of listed species, the EPA must consult with the Services regarding its pesticide approvals in order to comply with the ESA.

Fortunately the National Academy of Sciences (“NAS”) has provided guidance regarding the obligations of EPA and other wildlife agencies in analyzing pesticide approvals under the ESA. The NAS committee provided a report to the EPA and Services in April of 2013 providing specific recommendations relating to the use of “best available data,” methods for evaluating sublethal, indirect, and cumulative effects; the state of the science regarding assessment of mixtures and pesticide inert ingredients; the development, application, and interpretation of results from predictive models; uncertainty factors; and what constitutes authoritative geospatial and temporal information for the assessment of individual species, habitat effects and probabilistic risk assessment methods.³²

While the NAS report outlines areas for all three agencies to improve, the NAS report made several significant conclusions about the current ecological risk assessment process and its use of risk quotients (“RQs”), including:

- The EPA “concentration-ratio approach” for its ecological risk assessments “is ad hoc (although commonly used) and has unpredictable performance outcomes.”³³
- “RQs are not scientifically defensible for assessing the risks to listed species posed by pesticides or indeed for any application in which the desire is to base a decision on the probabilities of various possible outcomes.”³⁴
- “The RQ approach does not estimate risk...but rather relies on there being a large margin between a point estimate that is derived to maximize a pesticide’s environmental concentration and a point estimate that is derived to minimize the concentration at which a specified adverse effect is not expected.”³⁵

³⁰ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

³¹ CONSULTATION HANDBOOK at 3-13.

³² National Academy of Sciences 2013. *Assessing Risks to Endangered and Threatened Species from Pesticides* (hereafter NAS REPORT), Committee on Ecological Risk Assessment under FIFRA and ESA Board on Environmental Studies and Toxicology Division on Earth and Life Studies National Research Council (April 30, 2013).

³³ *Id.* at 107.

³⁴ *Id.* at 11.

³⁵ *Id.*

- “Adding uncertainty factors to RQs to account for lack of data (on formulation toxicity, synergy, additivity, or any other aspect) is unwarranted because there is no way to determine whether the assumptions that are used overestimate or underestimate the probability of adverse effects.”³⁶

According to the NAS, the EPA concentration-ratio approach contrasts sharply with a probabilistic approach to assessing risk, which the NAS describes as “technically sound.” The NAS’s underlying conclusion is that EPA should move towards a probabilistic approach based on population modeling, an approach that the NMFS already utilizes.³⁷ The NAS also recommends that the FWS move towards a probabilistic approach in its consultations.

Following the publication of the NAS report, the agencies have developed two policy documents to guide consultations on pesticide review and approvals moving forward: (1) *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes*,³⁸ and (2) *Interim Approaches for National-level Pesticide Endangered Species Act Assessments Based on Recommendations of the National Academy of Science April 2013*.³⁹ The agencies made clear at a November 15, 2013 public meeting that these new procedures and approaches would be “day forward” in their implementation.⁴⁰ Accordingly, approvals of pesticides and uses *must* follow these new *Interim Approaches* and comply with the requirements of the ESA.

A. Completion of Step One under Interim Approaches

As laid out in the National Academy of Sciences and *Interim Approaches* guidance, the risk assessment and consultation process should follow three steps.⁴¹ These steps generally follow the three inquiries of the ESA consultation process: (1) the “no effect”/ “may affect” determination (2) the “not likely to adversely affect”/ “likely to adversely affect” determination (3) the jeopardy/no jeopardy and adverse modification/no adverse modification of critical habitat determination. Step One generally follows the requirements of the ESA and will in most cases identify those species at risk from pesticides that need additional review through the informal and formal consultation process. At Step One, the EPA must gather sufficient data to complete the following two related inquiries: (1) the EPA must determine whether pesticide use areas will overlap with areas where listed species are present, including whether a use area overlaps with any listed species’ critical habitat (2) the EPA must determine whether off-site transport of pesticides will overlap with locations where listed species are present and/or critical habitat is designated. Off-site transport must include considerations of downstream transport due to runoff

³⁶ *Id.*

³⁷ *Id.* at 107.

³⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013).

³⁹ Available at <https://www.epa.gov/sites/production/files/2015-07/documents/interagency.pdf>

⁴⁰ INTERAGENCY APPROACH FOR IMPLEMENTATION OF NATIONAL ACADEMY OF SCIENCES REPORT: ASSESSING RISKS TO ENDANGERED AND THREATENED SPECIES FROM PESTICIDES, Public Meeting Silver Spring NOAA Auditorium (Nov. 15, 2013).

⁴¹ NAS REPORT at 37-38.

as well as downwind transport due to spray drift when the best available science indicates such transport is occurring.⁴²

What the EPA should do to meet the legal requirements of the ESA is use the best available spatial data regarding the pesticide use patterns and the distribution and range of listed species to determine whether a pesticide's use overlaps with species, and then make a "may affect"/"no effect" determination. The Fish and Wildlife Service ECOS website provides GIS-based data layers for each listed species with designated critical habitat.⁴³ These maps are scalable and can achieve the precision needed to make accurate effects determinations regarding whether a pesticide will have "no effect" or "may affect" a listed species and are certainly accurate enough to make determinations as to whether the use of a pesticide represents adverse modification of critical habitat. Figure One provides an overlay map from ECOS of all critical habitat that has been designated for listed species thus far.

Other sources provide additional data on the distribution and life history of threatened and endangered species. NatureServe provides detailed life history information, including spatial distribution, for native species across the United States.⁴⁴ In addition, many State governments collect detailed information on non-game species through their State Wildlife Action Plans.⁴⁵ In short, there are many sources of data that can provide EPA with the detailed information it needs to conduct an effects determination for each species. If there is a subset of species where it believes information is still lacking, EPA should make that clear to all stakeholders which species specifically it believes such data are lacking early in the process such that this information can be collected from the Services and other sources.

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⁴² The Center acknowledges that in many areas, atmospheric transport is difficult to model and assess. However, in some areas, the impacts of atmospheric transport of pesticides are well understood. A recent study found that a variety of pesticides are accumulating in the Pacific chorus frogs (*Pseudacris regilla*) through atmospheric deposition at remote, high-elevation locations in the Sierra Nevada mountains, including in Giant Sequoia National Monument, Lassen Volcanic National Park, and Yosemite National Park Smalling, K.L., et al. 2013. *Accumulation of Pesticides in Pacific Chorus Frogs (Pseudacris regilla) from California's Sierra Nevada Mountains*, Environmental Toxicology and Chemistry, 32:2026–2034.

⁴³ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁴ NatureServe Get data. <http://www.natureserve.org/getData/index.jsp>

⁴⁵ State Wildlife Action Plans. <http://teaming.com/state-wildlife-action-plans-swaps>

Figure One – Base Composite Map of Critical Habitat in the United States⁴⁶



To make scientifically valid effects determinations, EPA will also need the best available spatial data regarding the use of pesticides. The U.S. Department of Agriculture and the U.S. Geological Survey⁴⁷ collect data on an enormous suite of pesticide active ingredients each year, as do several private organizations. Thus, it should be possible to determine where areas of geographic overlap between species and pesticide usage occur. If empirical data on pesticide use or persistence in the environment is lacking geospatial modeling can be used to determine where pesticide use may overlap with affected endangered species.

With the completion of the problem formulations for Ecological Risk, the EPA should now move quickly to begin the informal consultation process for pesticides, starting with a spatial analysis as envisioned as Step one. If this information is collected and assessed properly, then it should then be relatively straightforward for the EPA to begin to develop geographic restriction on the use of pesticides wherever designated critical habitat for a listed species exists as parts of Step Two and Step Three. However, because not all threatened and endangered species have critical

⁴⁶ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁷ USGS, National Water-Quality Assessment (NAWQA) Program, Pesticide National Synthesis Project, Annual Pesticide Use Maps: 1992-2013, available at <https://water.usgs.gov/nawqa/pnsp/usage/maps/>

habitat, the EPA will also have to collect data on the distribution and range of species that do not yet have critical habitat to determine whether the use of these pesticides will jeopardize any of those species.

B. Label Requirements.

FIFRA requires that the EPA evaluate and reregister a pesticide every 15 years. During that 15 year period, crop distributions change, use patterns for pesticides change, and listed species change. By the time the registration review process is complete several years from now, additional species will almost certainly be protected by the ESA. Of the species currently listed, some may move towards recovery and become more common while others may become even more imperiled.

Product labels must be able to adapt to changing conditions on the ground to ensure that the use of these pesticides do not cause unanticipated adverse impacts that result in levels of take not authorized through the Section 7 consultation process. Fortunately, the EPA has already developed a system that can address impacts to endangered species and that provides for geographically-targeted conservation measures on the ground through its *Bulletins Live! Two* website.⁴⁸ The Center recommends that whenever a pesticide may affect listed species, both as a precautionary matter and as a mechanism to implement any conservation measures that are implemented in the informal and formal consultation process, the EPA use the *Bulletins Live! Two* system to incorporate these measures. Accordingly, all product labels for pesticides affecting endangered species must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁴⁹

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⁴⁸ U.S. Environmental Protection Agency Endangered Species Protection Bulletins.

<http://www.epa.gov/espp/bulletins.htm>

⁴⁹ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

II. The EPA Must Make Defensible “Not Likely to Adversely Affect” and “Likely to Adversely Affect” Determinations as a Prerequisite for Defensible “Jeopardy” and “No Jeopardy” Determinations.

At the informal consultation stage, the EPA must determine whether the use of a pesticide is either “not likely to adversely affect” (“NLAA”) a listed species or is “likely to adversely affect” (“LAA”) a listed species.⁵⁰ The Services define NLAA as “when effects on listed species are expected to be discountable, insignificant, or completely beneficial.” Discountable effects are those that are extremely unlikely to occur and that the Services would not be able to meaningfully measure, detect, or evaluate” because of their insignificance⁵¹ In the context of pesticides, only if predicted negative effects are discountable or insignificant can the EPA avoid the need to enter formal consultations with the Services. This is *not* a high threshold. The EPA is not required to make a determination as to whether exposure to a pesticide results in population level changes in order to request formal consultations. The Center believes that the Step Two approach described is generally compatible with the mandates of the ESA regarding actions that may affect listed species. The one in a million mortality threshold for “likely to adversely affect” reflects the ESA’s and the Consultation Handbook’s requirements. The decision to consider 1) sublethal effects to species, 2) additive, synergistic and cumulative effects of all chemicals and non-chemical stressors present in the pesticide formulation, tank mixture, and the environment, 3) and the fate and action of pesticide degradates at Step Two is also consistent with the ESA’s requirements and represents an important change from the previous EPA approach, in which the EPA was making policy judgments at Step Two as to whether known, adverse, population-level impacts crossed a severity threshold to warrant consultations.

Finally, the Center notes that at Step Three, the formal consultation process, the EPA and Services must consider the environmental baseline as well as all cumulative effects when determining if the approval pesticides, formulations, or uses will jeopardize any threatened or endangered species. The Services define environmental baseline as “the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process.”⁵² Cumulative effects are defined as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.”⁵³ Pesticide consultations must consider the interactions between the active ingredient under review and other pollutants in the present in the environment.

The Food Quality Protection Act of 1996 (“FQPA”) requires EPA to measure risk of a pesticide based on “... available information concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity.” The EPA has

⁵⁰ U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act*. at 3-1.

⁵¹ *Id.* at xv.

⁵² *Id.* at xiv.

⁵³ *Id.* at xiii.

interpreted this to mean that only pesticides with a common mechanism of action be assessed in a cumulative risk assessment. We strongly disagree with this interpretation. First, the term “other substances” can include chemicals other than pesticides and also stressors that are not chemicals, like radiation and climate change. The EPA itself defines cumulative risk as “the combined risks from aggregate exposures to multiple agents or stressors,” where agents or stressors can be chemicals or “may also be biological or physical agents or an activity that, directly or indirectly, alters or causes the loss of a necessity such as habitat.”⁵⁴ Second, the term “common mechanism of toxicity” does not dictate that the EPA only consider agents or stressors with a common mechanism of action. The National Research Council has recommended that the EPA use the endpoint of common adverse outcome rather than common mechanism of action to group agents that could act cumulatively.⁵⁵ As for how this relates to EPA’s duty under the ESA, cumulative risk in the ESA needs to be interpreted very broadly as this piece of legislation is a precautionary document meant to ensure that no harm comes to listed species. Although the EPA interprets the scope of cumulative risk assessments under FQPA to be limited to the common mechanism effect, **there is absolutely no such written or intended limit in the ESA**. The EPA needs to begin discussions on how it will test true cumulative risk, the way it is broadly defined in the ESA, because current metrics and protocols that measure cumulative risk under FQPA are inadequate for the EPA to meet its legal obligations under the ESA.

Pesticide and their residues and degradates do not occur in single exposure situations and many different mixtures of pesticides occur in water bodies at the same time.⁵⁶ The mixtures of these chemicals can combine to have additive or synergistic effects that are substantially more dangerous and increase the toxicity to wildlife.⁵⁷ Thus, to fully understand the ecological effects and adverse impacts, the EPA and the Services must consider the pesticide’s use in the context of *current* water quality conditions nationwide. In particular, the use of pesticides in watersheds that contain threatened or endangered species and where water quality is already impaired could be particularly problematic. Therefore, the agencies must use the best available data to fully inform its ecological risk assessment by considering water quality.

In conclusion, the EPA should move quickly to assemble the needed spatial data to make an informed “no effect” or “may affect” finding for *each* listed species that will likely overlap with the use of these pesticides or come into contact with its environmental degradates. If there is overlap, EPA must at a minimum conclude that the use of these pesticides “may affect” listed species. Where this occurs, EPA has a choice—(1) the EPA can elect to complete an informal consultation through a biological assessment (also known as a biological evaluation), or (2) the EPA can undergo formal consultation with the Services. If EPA completes a biological

⁵⁴U.S. Environmental Protection Agency 2003. Framework for Cumulative Risk Assessment. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/P-02/001F, 2003. Pg. xvii.

⁵⁵ National Research Council (US) Committee on the Health Risks of Phthalates. Phthalates and Cumulative Risk Assessment: The Tasks Ahead. Washington (DC): National Academies Press (US); 2008. Page 4.

⁵⁶ NMFS 2011, *Endangered Species Act Section 7 Consultation Draft Biological Opinion for the Environmental Protection Agency’s Pesticide General Permit for Discharges from the Application of Pesticides* (hereafter Draft BiOp) at 118-119, lines 4209-31; Gilliom, R.J. et al. 2006. *Pesticides in the Nation's Streams and Ground Water, 1992–2001—A Summary*, available at <http://pubs.usgs.gov/fs/2006/3028/>.

⁵⁷ Draft BiOp at 127-129, lines 4471-4515; Gilliom, R.J. 2007. *Pesticides in the Nation's Streams and Ground Water*, Environmental Science and Technology, 413408–3414.

assessment and implements geographically-tailored conservation measures through *Bulletins Live! Two*, it may be able to reach NLAA determinations via the informal consultation process and alleviate the need for formal consultations. In the alternative, the EPA can move directly to formal consultation after making “may affect” determinations for species where the impacts of pesticides are more complex and will take additional expertise to develop sufficient conservation measures. Cumulative effects need to be measured in Steps 2 and 3.

III. EPA and the Services Must Assess the Adverse Impacts on Critical Habitat.

Section 7 of the ESA prohibits agency actions that would result in the “destruction or adverse modification of [critical] habitat.”⁵⁸ This inquiry is separate and distinct from the question as to whether a pesticide approval will result in jeopardy to any listed species. A no jeopardy finding (or a Not Likely to Adversely Affect finding in an informal consultation) is *not* equivalent to a finding that critical habitat will not be adversely modified. While there is much overlap between these two categories (for example, as in *Tennessee Valley Authority v. Hill*⁵⁹ where the proposed agency action to build a dam would both destroy a species’ habitat and kill individual members of the species in the same time) many agency actions do result in adverse modification to critical habitat without causing direct harms to species that do rise to the level of jeopardy.⁶⁰ Indeed, the ESA’s prohibition on “destruction or adverse modification” of critical habitat does not contain any qualifying language suggesting that a certain species-viability threshold must be reached prior to the habitat modification prohibition coming into force.

As three federal circuit courts have made abundantly clear, avoiding a species’ immediate extinction is not the same as bringing about its recovery to the point where listing is no longer necessary to safeguard the species from ongoing and future threats. Therefore, Section 7 requires that critical habitat not be adversely modified in ways that would hamper the *recovery* of listed species.⁶¹ These potent pesticides with known adverse ecological effects have the potential to adversely modify critical habitat by altering ecological community structures, impacting the prey base for listed species, and by other changes to the physical and biological features of critical habitat. Accordingly, the informal consultation must separately evaluate whether these pesticide products and formulations will adversely modify critical habitat regardless of whether these pesticide products jeopardize a particular listed species. For example, if plant communities alongside a water body that has been designated as critical habitat suffer increased mortality, and this then results in increased temperatures or increased sedimentation, that would represent adverse modification of critical habitat. Likewise, if pesticides are toxic to species lower in the food chain, and a threatened or endangered species feeds on those affected prey species, this impact to the food web would represent a clear example of adverse modification to critical habitat.

⁵⁸ 16 U.S.C. § 1536(a)(2).

⁵⁹ 437 U.S. 153 (1978)

⁶⁰ See Owen, D. 2012. *Critical Habitat and the Challenge of Regulating Small Harms*. Florida Law Review 64:141-199.

⁶¹ See *Gifford Pinchot Task Force v. FWS*, 378 F.3d 1059, 1069-71 (9th Cir. 2004) (finding a FWS regulation conflating the requirements of survival and recovery to be unlawful); see also *N.M. Cattle Growers Ass’n v. FWS*, 248 F.3d 1277, 1283 n.2 (10th Cir. 2001); *Sierra Club v. FWS*, 245 F.3d 434, 441-42 (5th Cir. 2001)

EPA's evaluation must address impacts to critical habitat even if the direct effects on listed species fall below the NLAA or jeopardy thresholds. The Center recommends that the EPA design conservation measures—and implement those measures using *Bulletins Live! Two*—specifically to protect critical habitat of listed species from exposure to pesticides, and where appropriate, prohibit its use altogether in critical habitat where necessary. Doing so would provide meaningful, on-the-ground protections for hundreds of listed species, and may in some cases, help the EPA and the Services then reach a defensible NLAA or “no jeopardy” opinion.

IV. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on the Approval of All End-use Product Labels.

Just as the EPA must consult with the Services regarding the reregistration of an active pesticide ingredient, EPA must also consult with the Services regarding the registration or approval of end use and technical pesticide products. Such consultations must also occur at the earliest possible time to ensure that specific product formulations do not result in jeopardy for a listed species or adversely modify critical habitat.

In addition, because end use formulations may result in mixes of the active ingredient with “other ingredients” before application, the EPA must consider during the consultation process the effects of these “inert” or “other” ingredients together with the active ingredient on listed species and set appropriate conservation restrictions accordingly. As noted in *Washington Toxics Coalition v. U.S. Dept. of Interior*, “other ingredients” within a pesticide end product may cause negative impact to listed species even if they are less toxic than the active ingredient being reviewed.⁶² “Other ingredients,” such as emulsifiers, surfactants, anti-foaming ingredients, and fillers may harm listed species and adversely modify critical habitat. Many of the more than 4,000 potentially hazardous additives allowed for use as pesticide additives are environmental contaminants and toxins that are known neurotoxins and carcinogens.⁶³ The EPA has routinely failed to consult with the Services on the registration of “other ingredients,” potentially compounding harms to listed species by allowing such ingredients to be introduced widely into the environment. EPA must, as part of the consultation process, consider the range of potential impacts by using different concentrations and different formulations of the active ingredient, as well as the potential negative impacts of “other ingredients” used in end use products.

The National Academy of Science report recognized that without real-world considerations of where listed species are located, the relative conservation status of listed species, the environmental baseline, and the interaction of pesticides with other active ingredients, pesticide degradates, and other pollutants, the EPA risk assessment process will not be able to make meaningful predictions about which endangered species will be adversely affected. Until the EPA can conduct realistic assessments, it should take a precautionary approach and enter into formal consultations with the Services as outlined in the *Interim Approaches* document.

⁶² 457 F. Supp. 2d 1158 (W.D. Wash 2006).

⁶³ Draft BiOp at 113, lines 4062-68; 120-121, lines 4262-308; 127, lines 4445-4455; Northwest Coalition for Alternatives to Pesticides, et al., Petition to Require Disclosure of Hazardous Inert Ingredients on Pesticide Product Labels. 2006. http://www.epa.gov/opprd001/inerts/petition_ncap.pdf.

FESTF

**FIFRA Endangered
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August 31, 2016

Ms. Marquee King
USEPA Headquarters
Ariel Rios Building
1200 Pennsylvania Avenue, N. W. - Mail Code: 7509P
Washington, DC 20460

Concerning: Active Ingredient: Dicamba Case number: 0065
Docket number: EPA-HQ-OPP-2016-0223

Dear Ms. King,

In its Registration Review Preliminary Work Plan, EPA has noted that Dicamba has not had a complete endangered species determination performed to allow the Agency to determine whether the uses have “no effect” or “may affect” federally listed species or their designated critical habitats. At such time as an endangered species evaluation is conducted by EPA, the data developed by FESTF, in response to the Agency’s endangered species data requirements, will address species proximity to Dicamba uses.

In June of 2004, March of 2005, October 19, 2007, October 12, 2012, April 22, 2013, and June 1, 2015 the FIFRA Endangered Species Task Force (FESTF, Company Number 73989) submitted its Information Management System (FESTF Information Management System (IMS): Documentation of Structure and Function of IMS 1.1, MRID # 46325901) and documentation of the beta-tested IMS, NatureServe data (FESTF Task Force Information Management System (IMS): Beta-Tested IMS 2.0 and Access to NatureServe Data - Final Report, MRID # 46486301), NatureServe Data Evaluation and Review and description of the NatureServe Dataset Licensed by FESTF (MRID #'s 47260101 and 48969501), listed species attribute and aggregated location data (MRID #'s 48969502, 48969506, 49643402), information related to the proximity of listed species to pesticide use sites (MRID #'s 48969503, 48969504, 48969505 and 49272701), and an evaluation of and access to a licensed dataset containing the spatial locations of golf courses (MRID # 49643403). Additionally, FESTF is developing maps for each federally listed species utilizing FESTF’s aggregated species location data. The species maps are being developed in three phases; Phase 1 maps were submitted on February 20, 2015 (MRID # 49575201), Phase 2 maps were submitted on June 1, 2015 (MRID # 49643401) and Phase 3 maps were submitted on March 24, 2016 (MRID # 49880801). These data fulfill the data requirements spelled out in Pesticide Registration Notice 2000-2 and provide the best available data necessary to support the analysis of Dicamba use and listed species locations and potential exposure.

MEMBER COMPANIES

ADAMA Agricultural Solutions, Ltd.	Dow AgroSciences, LLC	MacDermid Agricultural Solutions, Inc.	Nufarm Americas, Inc.
Albaugh, LLC	DuPont Crop Protection	Monsanto Co.	PBI/Gordon Corp.
AMVAC Chemical Corp.	FMC Corp., Ag. Products	Nichino America, Inc.	Syngenta Crop Protection, Inc.
BASF Corp.	Gowan Company, LLC	Nippon Soda Co., Ltd.	Valent USA Corp.
Bayer CropScience	ISK Biosciences Corp.	Nissan Chemical Industries, Ltd.	



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The technical registrants, as identified on the fact sheet included in the Registration Review work plan, Monsanto Company, DuPont, BASF, Syngenta, Albaugh, MacDermid Agricultural Solutions, Inc., as the parent company for Arysta LifeScience North America, which are FESTF members and are entitled to rely on FESTF data (See Attachment A for our current list of members and companies who have reached an agreement allowing reliance on FESTF data submissions).

Sincerely,

(for)

Dan Campbell
Administrative Chairperson, FESTF
Chair, FESTF Administrative Committee
FIFRA Endangered Species Task Force, L.L.C.

cc: Joy Honegger, Monsanto Company
Richard Ambrose DuPont Crop Protection
Jeffrey Birk, BASF Corporation
Dan Campbell, Syngenta Crop Protection, Inc.
Morris Gaskins, Albaugh, LLC
Melinda Bowman, MacDermid Agricultural Solutions, Inc.
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ATTACHMENT A

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September 13, 2016

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c/o OPP Docket
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Dear Ms. Guilaran,

Please find enclosed Monsanto's comment on the dicamba preliminary work plan, the ecological problem formulation, and human health draft risk assessment Docket ID No. EPA-HQ-OPP-2016-0223.

Sincerely,

Jerry W. Cabbage, Ph.D.
Regulatory Affairs Manager

**COMMENTS OF MONSANTO COMPANY
ON THE DICAMBA AND DICAMBA BAPMA SALT
PRELIMINARY WORK PLAN (PWP)**

EPA-HQ-OPP-2016-0223

Submitted by:
Monsanto Company
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Monsanto Comments on Dicamba and Dicamba BAPMA Salt

Preliminary Work Plan (PWP)

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean	Statement: Executive Summary and 5.4.4 Chronic Dietary Risk Assessment: "...most highly exposed population subgroup is children ages 1-2...42% of the cPAD."	5, 37	Comment: The text, while consistent with the select data presented in the summary table in 5.4.6, does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba. Acute and Chronic Dietary Exposure Assessments of Food and Drinking Water to Support the Use of Dicamba on Dicamba-Tolerant Cotton and Soybean for Amended Section 3 Registration, and Registration of the New N,N-Bis-(3-aminopropyl) methylamine (BAPMA) Salt Formulation	Statement: Executive Summary: "...most highly exposed...children ages 1-2...42% of the cPAD." VII. Results/Discussion: "...chronic...children 1-2 years old had the highest chronic dietary risk at 42% of the cPAD." IX. Conclusions: "...chronic...Children 1-2...42% cPAD."	2 9 10	Comment: The text, while consistent with the select data presented in summary Table 5 (p 10) does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-	Memorandum. Dicamba and Dicamba	Statements in 4.3 – 4.5 (including subsections)	20 - 28	Comment: There appear to be inconsistencies both

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
2016-0223-0002	BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean			within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. See Appendix 1 to this document for specific comments.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available”</i>	4	Comment: These studies have already been submitted. Freshwater (Fathead Minnow): Acute: MRID 48718008 ELS: MRID 48718010 Saltwater (Sheepshead Minnow) ELS: MRID 48718011

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
	Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species”</i></p>	4	<p>Comment: This study has already been submitted. MRID: 48718013</p>
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)</i></p> <p><i>Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.</i></p> <p><i>Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies “</i></p>	4	<p>Comment: A chronic study with worker bees has been reported in the published literature which could be used to evaluate the potential chronic effects Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. A bee brood study with dicamba is available from the published literature that could be used to evaluate potential chronic effects of dicamba on newly emerged honey bees. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental</p>

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
				Entomology 1:611-614.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using dicamba’s metabolite, DCSA and the same species as used in the test with TGAI dicamba.”</i>	5	Question: Is the fish ELS study for DCSA required only for a freshwater species?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).”</i>	5	Comment: A residue decline study is available for dicamba on dicamba tolerant soybeans. The foliar dissipation of DCSA can be calculated from this study: “Determination of Dicamba Residue Decline in Forage after Application to Dicamba-Tolerant Soybean MON 87708 × MON 89788” MSL0022493. Also, there is foliar dissipation information for dicamba and DCSA in the magnitude of the residue study for dicamba tolerant soybeans: “Magnitude of Residues of Dicamba in Soybean Raw Agricultural and Processed Commodities after Application to MON 87708. MRID 48219901
EPA-HQ-OPP-2016-	Problem Formulation for the Environmental	Data Needs: <i>“Any new formulations for which an Endangered Species Act effect determination must</i>	5	Comment: The request for a Terrestrial Plants Field Study (850.4300) is not discussed elsewhere

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
0223-0004	Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<i>be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300)."</i>		in the Problem Formulation document. Please provide additional information regarding what type of study is being requested.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>"It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury."</i>	9-10	Comment: If EPA is referring to the literature references cited in Footnote 1 on Page 7 of "Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)", it is important to note that none of the studies identified by EPA quantified or assessed vapor drift in any way. All of the reviewed papers intentionally made direct applications of dicamba at low rates to simulate particle drift – not volatilization – in order to assess plant effects at known rates.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Statement: <i>"... no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this</i>	13	Correction: Chronic studies on fathead minnow, sheepshead minnow, Daphnia magna, and mysid shrimp have been submitted. See Comments above for Page 4.

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
	Review of Dicamba	<i>uncertainty.”</i>		
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>“as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA.”</i>	14	Correction: Chronic studies on fathead minnow and <i>Daphnia magna</i> are available for dicamba. See Comments above for Page 4.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2: Freshwater fish; Chronic (Early Life-Stage); No Data	14	Addition: Fathead Minnow NOAEC = 9.7 mg a.e./L MRID 48718010
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 4: Freshwater invertebrates; Chronic; No Data	14	Addition: <i>Daphnia magna</i> NOAEC = 42 mg a.e./L MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 6 Estuarine/marine fish; Chronic (Early Life-Stage); No Data	14	Addition: Sheepshead Minnow NOAEC = 11 mg a.e./L MRID 48718011

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	Drinking Water Assessments in Support of the Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 1 of Page 15 Estuarine/marine invertebrates; Acute; Grass shrimp EC ₅₀ >100 mg a.e./L	15	Question: EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) has the following endpoint: Grass shrimp EC ₅₀ > 132 mg a.e./L Which is correct?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2 of Page 15: Estuarine/marine invertebrates; Chronic; No Data	15	Addition: Mysid shrimp NOAEC = 11 mg/L MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 7, Row 1: Dicamba dimethylamine salt Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 > 112.4 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 > 977 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-	Problem	Table Endpoint:	15	Question:

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 8, Row 1: Dicamba sodium salt Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 = 111.6 mg a.e./L		The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 507.2 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 8, Row 2: Dicamba sodium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 9.2 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr EC50 34.6 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 10, Row 1: Dicamba potassium salt Bluegill Sunfish <i>Lepomis macrochirus</i> 96-Hr LC50 = 73.2 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 196 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Table Endpoint: Table 10, Row 2: Dicamba potassium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 301 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr

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	Assessments in Support of the Registration Review of Dicamba			EC50 639.8 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 1, Line 5: No acute oral data is available for dicamba's toxicity to passerine birds	17	Comment: A study for a passerine species has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 2, Line 4: Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees.	17	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993). Published literature studies report testing dicamba in a bee brood study and a chronic study with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614.

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EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 1: Birds, Acute Oral	18	Comment: Please clarify which study and endpoint the MRID number 42918001 refers to.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 2 Birds, Acute Oral (passerine) No data		Comment: An acute oral study for a passerine species is available with an endpoint LC50 > 213 mg a.e./kg bw. MRID 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 3 Subacute dietary: TGAI/TEP – 86.8%	18	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) indicates that the TGAI/TAP % ai is 86.6%
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Study Classification: Table 12, Row 3 of Page 19 Terrestrial Invertebrate Acute Contact (adult): The study is classified Supplemental / Quantitative.	19	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) lists MRID 00036935 as Acceptable. Please provide an explanation

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	Assessments in Support of the Registration Review of Dicamba			for any change in classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 4 Terrestrial Invertebrate Acute Oral (adult)	19	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 1 Birds, Acute Oral: Mallard Duck <i>Anus Platyrrhynchos</i> 14-D LC50>282 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >2452 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 2 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrrhynchos</i> 8-D LC50>2185 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4533 mg a.e./kg.
EPA-HQ-OPP-	Problem Formulation for the	Endpoint: Table 14, Row 1 Birds, Sub-acute dietary:	20	Comment: Has there inadvertently been a double correction

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
2016-0223-0004	Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Bobwhite quail <i>Colinus virginianus</i> and 8-D LC50>2409 mg a.e./kg-bw		for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >9090 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 15, Row 1 of Page 21 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i> 8-D LC50>609 mg a.e./kg-bw	21	Correction: There has inadvertently been a double correction for acid equivalent content of the test substance. The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >1522 mg a.e./kg. This is consistent with an a.e. correction in the Science Chapter since the test substance was tested at 5620 ppm.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 16, Row 1 on Page 21 Birds, Acute Oral: Bobwhite quail <i>Colinus virginianus</i> 14-D LC50 = 235 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as 618 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Endpoint: Table 16, Row 1 on Page 22 Birds, Subacute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i>	22	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
	Assessments in Support of the Registration Review of Dicamba	8-D LC50>1822 mg a.e./kg-bw		for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4794 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 17, Row 2 Chronic (2-Generation Reproduction: Laboratory rat <i>Rattus norvegicus</i> NOAEL = 8 mg a.e./kg-diet/day LOAEL = 78 mg a.e./kg diet/day Endpoints: decreased pup weights	22	Comment: EPA's detailed analysis is not available to Monsanto; however, in general BMDL ₅ is a better, more refined estimate to use as a basis (point of departure) for the chronic risk assessment. In this case, 34.9 mg a.e./kg/day is the most appropriate value to use for the chronic risk assessment.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Study Classification: Table 19, Row 6 Aerobic Aquatic Metabolism: MRID 43758509 is listed as Supplemental	28	Comment: The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) classified this study as Acceptable. Please provide an explanation for the change in study classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 19, Row 5 of Page 29 MRID 49067704 is indicated to be a Field Volatility Study		Correction: MRID 49067704 is a field dissipation study
EPA-	Problem	Study Classification:	30	Comment:

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 20, Row 14, Page 30 Freshwater fish; Acute: MRID 00258932 is classified as Supplemental / Quantitative		MRID 258932 is classified as Supplemental / Qualitative in the EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 16, Page 30: Fresh invertebrates life cycle: No data	30	Comment: A <i>Daphnia</i> lifecycle study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 1, Page 31: Saltwater invertebrates life cycle: No data	31	Comment: A mysid lifecycle study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the	Data Needed: Table 20, Row 2, Page 31: Freshwater fish early-life stage: No data	31	Comment: A fathead minnow early-life stage study has already been submitted. MRID 48718010

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	Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 4, Page 31: Saltwater fish early-life stage: No data	31	Comment: A sheepshead minnow early-life stage study has already been submitted. MRID 48718011
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 32: Avian oral toxicity: No data on a passerine species	32	Comment: A passerine acute oral toxicity study has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 33: Honey bee adult acute oral toxicity (Tier 1): No Data	33	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-	Problem Formulation for the Environmental Fate, Ecological	Data Needed: Table 21 Honey bee adult chronic and larval acute and chronic testing: No Data	33-35	Comment: Published literature studies report testing dicamba in a bee brood study and a chronic study

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0004	Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba			with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614. These data could be used to evaluate whether chronic exposure to dicamba has any effects on honey bees.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 21, Last Row, Page 36 Vegetative Vigor: MRID 47814102	36	Correction: The MRID number should be 47815102
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Table A1.	38	Comment: Many of the rates given in this table do not seem to reflect the use rate limitations required in the 2009 Registration Eligibility Decision. Single Application Maximum – 1 lb a.e./A. Annual Application

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	Review of Dicamba			Maximum – 2 lb a.e./A.

`Appendix 1 to Monsanto Comments on Dicamba Registration Review Documents

EPA's Human Health Risk Assessment (HHRA) demonstrates that there is a reasonable certainty of no harm to the general public, including infants and children, from the proposed new uses of dicamba on dicamba-tolerant soybean and cotton.¹ However, EPA's decision to establish a chronic reference dose (cRfD) for dicamba of 0.04 mg/kg/day based on a Point of Departure (POD) of 4 mg/kg/day determined from the 2-generation rat reproduction study with the DCSA metabolite is extremely conservative and appears to lead to inconsistencies both within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. This decision is also inconsistent with (i.e., more conservative than) the conclusions of the Joint FAO/WHO Meeting on Pesticide Residues (JMPR).

Section 5.1.4 of the HHRA states, "Based on available toxicity studies and structural similarities, HED considers the parent and all three metabolites [DCSA, DCGA and 5-OH dicamba] to be of comparable toxicity." This is similar to the JMPR (2010) conclusion that "DCSA and DCGA have toxicity similar to or lower than that of dicamba" while 5-OH dicamba "appears to be of lower toxicity than the parent." In contrast, Section 4.3 of the HHRA indicates that DCSA is approximately 12-fold more toxic to offspring than dicamba acid. The latter statement is apparently based on the most recent EPA conclusions regarding the multi-generation rat reproduction studies with both compounds that were conducted at different times in different laboratories. Although full details are not available, this conclusion appears to be based, at least in part, on different Agency approaches used in evaluating or re-evaluating pup weights. Slight decreases in pup weight or pup weight gain relative to concurrent control were apparently reported in only one generation of both studies at 500 ppm. For DCSA, F1 pup weights at 500 ppm were lower than the concurrent control but were similar to those observed in the F2 controls as well as the laboratory's historical control values and were thus not considered to be a treatment related adverse effect. Although JMPR agreed with this conclusion, EPA concluded that 500 ppm was a Lowest Observed Adverse Effect Level (LOAEL). This resulted in a No Observable Adverse Effect Level (NOAEL) of 50 ppm, the next lowest concentration tested. In contrast, for dicamba, EPA apparently recently concluded that the decreased pup weights reported in one generation at both 500 and 1500 ppm were not treatment related due to the values being comparable to historical control data. EPA thus raised the dicamba offspring NOAEL from 500 ppm to 1500 ppm. It is not clear why comparisons to historical control data were acceptable for dicamba but not for DCSA. However, the end result is that although both the DCSA and dicamba studies appear to have similar marginal responses at 500 ppm, EPA conclusions regarding offspring NOAELs for these molecules are now quite different, 50 ppm and 1500 ppm, respectively. This does not appear to be consistent with the EPA conclusion that the two molecules exhibit comparable toxicity.

The EPA decision to reduce the chronic reference dose (cRfD) for dicamba from 0.45 to 0.04 mg/kg/day and to use this value for dietary risk assessment also does not appear to be justified. DCSA is only a very minor metabolite in conventional crops. Accordingly, the primary source for DCSA in the diet from the proposed uses will be from use of dicamba on dicamba-tolerant soybean (cotton consumption is negligible). However, based on the EPA analysis, potential residues in soybean represent only a very small percentage of the total dietary intake of dicamba. As a result, the vast majority of dietary exposure will be to parent dicamba, not DCSA.

¹ M1768 and M1769 herbicides would also be covered under the current HHRA for dicamba.

Therefore, it would seem more appropriate to assess the risks from these residues utilizing a cRfD based on dicamba data rather than an 11-fold lower cRfD based on a marginal response seen in a DCSA study.

The cRfD of 0.04 mg/kg/day proposed by EPA for use in dietary risk assessment is much lower than the value recommended by JMPR. JMPR concluded that the NOAEL for both the dicamba and DCSA rat reproduction studies was 500 ppm (~35 mg/kg/day for dicamba and ~37 mg/kg/day for DCSA). JMPR then concluded that an Acceptable Daily Intake (ADI) of 0.3 mg/kg/day was appropriate to characterize potential risks to both dicamba and its metabolites. This value was based on the NOAELs from the rabbit teratology and rat reproduction studies with dicamba and a 100-fold uncertainty factor.

Finally, the use of a Point of Departure (POD) of 4 mg/kg/day from the DCSA rat reproduction study for determining the cRfD for dicamba seems inconsistent with information included in the Second Addendum to the Environmental Fate and Ecological Risk Assessment (March 24, 2016). According to that document, EPA has conducted a benchmark dose analysis of the DCSA reproduction study and concluded that the threshold value for the NOAEL would be 8 mg/kg/day and that the lower 95% confidence limit on the benchmark dose resulting in a 5% change from background (BMDL₅) would be 34.9 mg/kg/day. It is not clear why these analyses were not summarized and utilized in the selection of the POD and cRfD in the HHRA.

**Dicamba
Final Work Plan (FWP) Team Meeting
December 1, 2016
PYS-9100
10:00-11:00am**

Team Members

- BEAD: Monisha Kaul, Bill Chism, Claire Paisley-Jones, Andrew Lee, Tim Kiely
- EFED: Michael Wagman, Nathan Miller, William Eckel, Monica Wait, Mark Corbin
- HED: Sarah Dobreniecki, William Irwin, Kelly Lowe, Pete Savoia, Mike Metzger
- PRD: Marqueea D. King (CRM), Melanie Biscoe (TL), Linda Arrington (BC)
- RD: Karen Samek, Kathryn Montague, Grant Rowland, Dan Kenny

1. Introductions

2. PRD Overview

- Status of FWP

3. Team Response to Comments

- Review team responses to public comments (draft)

4. Next Steps

- Publication/review timeline

TOXIC CONCOCTIONS

HOW THE EPA IGNORES THE DANGERS OF PESTICIDE COCKTAILS.



BY NATHAN DONLEY, PH. D.

CENTER FOR BIOLOGICAL DIVERSITY

JULY 2016

Executive Summary

More than 1 billion pounds of pesticides are used in the United States each year, applied to agricultural fields and orchards, residential lawns, playgrounds and parks. Pesticides are often mixed with other pesticides and chemicals before application or after, and the individual ingredients in these mixtures can interact in such a way as to enhance their toxic effects. **This is referred to as “synergy,” and it can turn what would normally be considered a safe level of exposure to people, wildlife and the environment into one that causes considerable harm.**

Although pesticide mixtures in the environment have been extensively documented, the Environmental Protection Agency generally only assesses the toxicity of pesticides individually, in isolation from potential real-life scenarios where these pesticides may interact with other chemicals. The EPA, which is tasked with ensuring that pesticides do not result in unreasonable harm to human health and the environment, often rationalizes this approach by stating that studies measuring mixture toxicity are often not available for analysis.

Our analysis, however, contradicts that claim by utilizing a publicly available information source (data from the U.S. Patent and Trademark Office) that provides a disturbing snapshot of pesticide synergy and the potential for widespread danger to people, waterways and wildlife — risks the EPA has repeatedly failed to identify and consider during its approval process.

For this report we conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta).

Among our key findings:

- 69 percent of these products (96 out of 140) had at least one patent application that claimed or demonstrated synergy between the active ingredients in the product;
- 72 percent of the patent applications that claimed or demonstrated synergy involved some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, among others, indicating that potential impacts could be widespread.

This suggests that synergistic action between pesticide active ingredients is much better documented and more common than current EPA pesticide assessments would indicate. Further, it appears that pesticide companies are in fact collecting information about the synergistic effects of their products that they are not sharing with the EPA. Recognizing that pesticide synergy data are widely available and that the synergistic relationships between pesticides can have serious implications for human and environmental health, the EPA must now take action to properly consider the potential consequences of pesticide synergy.

Introduction

Pesticide Registration

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), before a pesticide can be sold or distributed in the United States it must be registered — that is, approved — by the EPA. By law the EPA can only register a pesticide if its use will not cause unreasonable adverse effects on the environment.¹ To analyze whether any possible adverse effects may occur, the agency requires that toxicity studies be submitted to it by the chemical companies that plan to sell the pesticide (subsequently referred to as “pesticide registrants”). These studies typically analyze the relative toxicities of the pesticide to different taxa of plants and animals.² Once these data are analyzed, the EPA conducts a cost-benefit analysis that weighs the environmental costs with the purported economic benefits of pesticide use and decides whether or not to register a given pesticide.

The data that are required to be submitted by pesticide registrants almost always involve the use of a single pesticide in the absence of any other added chemicals. In reality pesticide exposures never occur in isolation. Pesticides are typically sold as formulations, meaning the pesticide is mixed with other chemicals in the bottle. These other chemicals can be other pesticides or “inert” ingredients, which are chemical additives that can affect the toxicity or absorption of the pesticide.³ In addition, pesticide products are often mixed in the field before application with other ingredients called “adjuvants”⁴ and/or other pesticide products. Pesticides that are applied on different geographic areas can also migrate away from the site of application and mix together in the environment.⁵ The EPA toxicity data requirements from chemical companies that focus on a single ingredient, combined with the fact that government and academic researchers often don’t have the means to study the vast landscape of mixture toxicity in sufficient detail, leads to an enormous gap in our knowledge of pesticide mixture toxicity.

Chemical Interactions

When chemicals mix in the environment, one of two things can happen: 1) the chemicals can interact in such a way as to change their toxicity profiles or 2) no interaction occurs. When chemicals do not interact, this is generally referred to as “additivity,” which means that no chemical in the mixture influences the toxicity of the other chemical(s) and toxicity can be estimated by how the chemicals act on their own. Alternatively, chemicals can interact to increase or decrease toxicity beyond the sum of the individual effects, which is referred to as “synergism” or “antagonism,” respectively.⁶ Synergism is particularly worrisome from a regulatory point of view, because, if it is not properly taken into account, adverse effects on human health or the environment can be much greater than originally estimated.

The EPA’s current guidance on how to assess mixture toxicity to humans directs the agency to assume that no interaction is occurring as a default unless available data indicate otherwise.⁷ In practice, because of the enormous data gaps on mixture toxicity, the EPA almost exclusively ends up assuming “no interaction” when the agency analyzes mixture toxicity to humans. There is currently no guidance on how the EPA assesses mixture toxicity to plants and animals other than humans, and the ecological risk assessment process does not generally assess pesticide mixture toxicity.⁶

Patent Applications

The extensive gaps in our knowledge of mixture toxicity ultimately weaken the EPA’s ability to effectively regulate pesticides, and new sources of data need to be identified. One new source of data was recently brought to the forefront with EPA’s approval of Enlist Duo, a new pesticide product from Dow that combines glyphosate and 2,4-D into one formulation for use on second generation genetically engineered crops. Following its registration of Enlist Duo, in preparing to defend itself in subsequent litigation on the registration

decision, the EPA came across a patent application from Dow that indicated glyphosate and 2,4-D result in synergistic toxicity to plants. This meant that the EPA's evaluation of the product at the registration phase lacked a full consideration of impacts to nontarget plants, including endangered species. The discovery of this patent application spurred the EPA to further request any relevant data from Dow about possible synergies and ultimately ask a court to vacate its decision to register Enlist Duo.⁸

When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office (USPTO) has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant.⁹ For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

In the case of Enlist Duo, the fact that publicly available data from a patent application was unknown to the EPA until it was working to defend itself in litigation highlights just how broken this process is. Enormous data gaps, coupled with nonconservative measures of mixture toxicity, have created a precarious framework of assumptions that, in many cases, underestimates the toxicity of pesticide mixtures to humans and the environment.

Analysis

Pesticide Products

For this analysis we sought to understand just how extensive the patent landscape was regarding claims of pesticide synergy. To ensure that our analysis was relevant to pesticide mixtures that were going to be encountered in the environment, we limited it to products that

contain multiple pesticide ingredients (subsequently referred to as "active ingredients"). Specifically, we identified all of the products from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta — hereafter referred to as "The Big Four") the EPA approved in the past six years that contained two or more active ingredients.¹⁰ This way we identified pesticides that were absolutely certain to be co-applied because they are sold together in a single product. A more detailed description of our methodology is outlined in Appendix A.

We found 140 products from The Big Four, approved between June 2010 and June 2016, that contained at least two active ingredients. Each product contained anywhere from two to six active ingredients, and all were characterized as an herbicide, insecticide or fungicide/nematicide. The largest group of multi-ingredient products from The Big Four that have been approved in the past six years was herbicides, accounting for 67 of the 140 products. A breakdown of the products by company indicates that Bayer, Dow, Monsanto and Syngenta had 49, 26, 5 and 60 products that were included in our analysis, respectively.

Synergy Patents

We then searched various databases for patent applications that made a claim of synergy for at least two of the active ingredients in the product (methodology outlined in Appendix A). Only patent applications submitted to the USPTO were included in this analysis; patent applications in other countries were excluded. All patent applications that were granted, denied or still in the application process were included in our analysis because the status of the application has no bearing on the underlying accuracy of the synergy claims. The USPTO generally does not pass judgment on whether synergy exists or not; it takes applicants at their word, only considering whether the claims are nonobvious and therefore patentable.

Remarkably, of the 140 pesticide products included in our analysis that contain multiple active ingredients, 96 had at least one patent

application that claimed or demonstrated synergy between the active ingredients in the product, a total of 69 percent (Figure 1a and Appendix B). These 96 products had at least one patent application and as many as six, claiming or demonstrating synergy between the active ingredients in the product. The majority of patent applications contained experimental data that were included in the application as evidence of the claimed synergy. For all patent applications, synergy was claimed or demonstrated for target organisms (i.e. synergistic toxicity to target insect species for insecticidal ingredients). A breakdown of the patent synergy claims by company indicates that 71 percent (35/49), 46 percent (12/26), 40 percent (2/5) and 78 percent (47/60) of Bayer, Dow, Monsanto and Syngenta products had patent applications that claimed synergy between at least two of the active ingredients in the product, respectively.

As some of the approved products contained similar ingredients, many patent applications covered multiple products. There were a total of 47 patent applications that covered the ingredient mixtures in the products included in our analysis.¹¹ Many of the ingredients covered by

these patent applications are very widely used, with 72 percent (34/47) of patent applications involving high use ingredients (more than 1 million pounds used per year in the U.S. agricultural sector) (Figure 1b).¹²

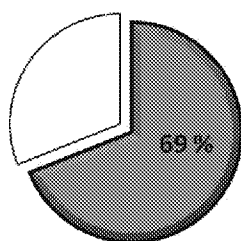
Acuron, a case study

In 2015 the EPA conditionally registered a pesticide product from Syngenta called Acuron (EPA Reg. No. 100-1466, Decision No. 470872). Acuron combines four different active ingredients — bicyclopyrone, S-metolachlor, mesotrione and atrazine — into a single formulation to control weeds in cornfields. The approval of the Acuron product was combined with the approval of the new active ingredient bicyclopyrone, and therefore went through public review and comment.¹³

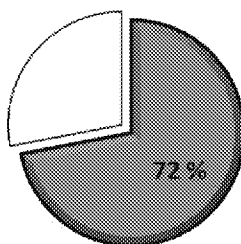
In response to the Center for Biological Diversity's public comments regarding possible synergistic effects of Acuron, the EPA stated: "Concerning synergistic effects, the agency does not routinely include a separate evaluation of mixtures of active ingredients. However, there are some data available to the agency regarding synergistic effects and EPA believes it adequately addressed the issue of synergism between bicyclopyrone and atrazine."¹⁴ But the EPA provides no information on how it addressed this issue of synergism as there is no mention of this analysis in the ecological risk assessment,¹⁵ no separate analysis was provided to the public, and there was no mention of whether synergy was analyzed for ingredient combinations other than bicyclopyrone and atrazine. The agency further indicated that a study of acute toxicity of Acuron to mammals was analyzed and did not indicate synergy was occurring.¹⁴ However, it did not analyze chronic toxicity to mammals or acute and chronic toxicity to all other taxa like birds, fish, invertebrates and plants as a result of Acuron exposure prior to approving this product.

As Acuron is a Syngenta product that was approved in the past six years, it was included in our patent analysis. We found three patent applications claiming synergistic toxicity to plants

Fig 1 A) Percentage of Recently Approved Multi-ingredient Products That Have Evidence of Synergy



B) Percentage of Identified Synergy Patents That Involve High Use Ingredients



from exposure to the ingredients in this product: the combination of 1) S-metolachlor and mesotrione (app # 12374219), 2) mesotrione and atrazine (app # 12675156) and 3) atrazine and S-metolachlor (app # 08930901) (Appendix B). Since bicyclopyrone has the same mode of action as mesotrione,¹⁶ it is likely that any synergy observed with mesotrione and other ingredients will be present with bicyclopyrone and those ingredients as well. Synergistic toxicity of mesotrione and atrazine to certain species of plants has also been extensively documented in the literature.^{17- 22} Finally, in publicly available promotional materials for Acuron, Syngenta has not only claimed that mesotrione and bicyclopyrone work synergistically with atrazine to kill plants, but they have mapped out the exact mechanism by which synergy occurs.²³

It is clear that there are at least three and as many as five layers of synergy that result from the combination of ingredients in Acuron (Figure 2). This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them. The EPA is charged with ensuring that pesticide use results in no unreasonable adverse effects to the environment or harm to endangered or threatened species. It is still unclear how the agency came to its conclusion for Acuron without properly considering this publicly available, relevant information.²⁴

Discussion

Our analysis indicates that there are patent applications claiming or demonstrating synergistic action for 69 percent of the recently approved products from The Big Four pesticide companies that contain multiple active ingredients. This percentage is very high and disconcerting. Synergy between chemicals is not generally thought to be a very common phenomenon, which is one reason regulatory agencies typically assume additivity. However, in the case of premixed products, this high percentage makes perfect sense. Combining synergistically acting chemicals into a single product not only allows a company to gain patent protection on the combination of ingredients in their product, but, from a product performance point of view, it makes sense to combine ingredients that will enhance each other's ability. Unfortunately enhancing toxicity to target organisms will often enhance toxicity to many nontarget organisms as well. Perhaps most worrisome is that 72 percent of the patent applications we identified claimed or demonstrated synergy with some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, indicating that potential impacts could be widespread.

We're also certain that 69 percent is an *underestimate* of how many of these products have synergistic activity. There are multiple reasons for this conclusion:

1. We only took into account U.S. patent applications. In our search we found multiple relevant patent applications filed with other countries as well as with the World Intellectual Property Organization (WIPO). For example, a U.S. patent application could not be identified for the product combining methoxyfenozide and spinetoram (EPA reg No. 62719-666), however Dow submitted a patent application

Fig 2

Synergy Evidence for Acuron (mesotrione, S-metolachlor, bicyclopyrone, atrazine)

Line of evidence	patent claim	published studies	promotional materials	based on mode of action
S-metolachlor + mesotrione	X			
mesotrione + atrazine	X	X	X	
S-metolachlor + atrazine	X			
bicyclopyrone + atrazine			X	X
bicyclopyrone + S-metolachlor				X

to the WIPO claiming that this active ingredient combination works synergistically to kill an insect target organism.²⁵

2. Many relevant patent applications may not be publicly available yet. The products that we analyzed were approved relatively recently, and it is therefore likely that some relevant patent applications were filed recently as well. The USPTO delays the publishing of patent applications for 18 months after the date of first filing.²⁶ So any patent applications filed within the past year and a half may not be publicly available and would not have been identified by our search strategy.
3. Because “inert” ingredients in pesticide products are not made available to the public, we were unable to search for patent applications that demonstrated synergy between the active ingredients and other ingredients contained in the pesticide product. We did come across many patent applications claiming synergy between the active ingredients in the analyzed products and commonly used “inert” ingredients;²⁷ however, the lack of ingredient transparency in pesticide products prohibited the inclusion of possibly relevant patent applications. Therefore, more layers of synergy may be present in these products than were identified in this analysis.
4. Searching for patent applications is surprisingly difficult. It is possible that our search strategy (Appendix A) missed relevant patent applications.
5. We only searched for claims of synergy in patent applications. As was the case with Acuron, some of these chemical combinations may have been demonstrated to act synergistically on target or nontarget organisms in peer-reviewed scientific studies. Any such study would not have been identified in our analysis. Furthermore, any unpublished, internal studies done by chemical companies would, of course, not be identified either.

Pesticide companies likely possess additional information regarding pesticide synergy that they do not include in their patent applications. Patent applications are very different from scientific studies, which are the typical data source used by the EPA to assess risk. The latter are very descriptive and data intensive, while the former provide the bare minimum of information required to demonstrate to the patent office that their claim is legitimate. This does not necessarily mean that experimental data provided in patent applications are somehow less scientifically valid than data from scientific studies, only that more data may be available from the patent applicant than was provided to the patent office. The EPA acknowledged this fact in the Enlist Duo case by not just relying on the information contained in the relevant patent application, but also requiring Dow to submit any relevant data on the synergy between glyphosate and 2,4-D that was in its possession.⁸ In many cases the patent applicant will have additional data on synergism in their possession, as extensive experimentation is typically done before a company will invest the time and money to develop a product that they intend to market. It is important that this be kept in mind when scientifically evaluating the data contained in patent applications.

We cannot say with absolute certainty that the patent data on synergy that we identified were not used in making registration decisions for these products. There are multiple reasons for this. The first is that, unlike Acuron, many individual products are given approval without public review and comment, so the analysis that went into the product approval, if any, is not shared with the public. Second, even when products do go through public review and comment, a mixture toxicity analysis is either not performed or not outlined in sufficient detail for the public to understand all of the lines of evidence that were used. However, given that, in the case of Enlist Duo, the EPA indicated that it just recently became aware that patent data on synergy exist and the fact that it is not common practice to do a mixture analysis for the ecological risk assessment, we think it is extremely likely

that most, if not all, of these product approvals were made without taking into account this relevant patent information.

It is also unclear why the EPA has not previously been made aware of these patent data by pesticide registrants. Registrants are required to submit information to the EPA that could raise concerns about the continued registration of a product or about the appropriate terms and conditions of registration.²⁸ For example, pursuant to 40 CFR §159.195(a)(3), the registrant is required to submit information that indicates “[u]se of a pesticide may pose any greater risk than previously believed or reported to the Agency.” Data on chemical synergy would certainly fall into that category. It appears that chemical companies are using synergy to demonstrate that chemical combinations have some sort of novelty associated with them and are, therefore, patentable — yet when it comes to the toxicities associated with this synergy, this information never makes it to the EPA.

Recommendations

Searching for patent applications can be a difficult process that takes considerable time and knowledge. Often the pesticide is not referred to by its common name in the patent application, making a simple keyword search insufficient to identify all relevant patent information. The EPA cannot rely on stakeholders to provide all of the necessary information from patent applications, but rather the EPA must place the burden to produce and submit information related to synergistic effects squarely where it belongs: on the pesticide registrant or applicant.

1. Registrants or applicants need to be made aware that failure to submit relevant data to the EPA will be a violation of their duties under Section 6(a)(2) of FIFRA.²⁹ When applicable, enforcement should be pursued when registrants fail to provide those data.
2. To identify patent data that are not affiliated with the pesticide registrant, the EPA needs to use a stepwise approach of

doing a keyword and structure search for patent applications concerning the pesticide of interest followed by a rigorous analysis of the claims in the patent application.

3. Any claims of synergy need to be assessed for relevance given the label restrictions for the pesticide (or lack thereof) and the inert ingredients that are present in any formulation up for approval.
4. Appropriate measures need to be taken to ensure that any registration decision is compliant with FIFRA. This may include label restrictions on mixing, increased in-field buffers, lower application rates or even product cancellation.

A full analysis of mixture toxicity needs to be taken into account for both the human health and ecological risk assessments. When patent applications or other data demonstrate synergistic toxicity to target organisms, that synergy needs to be assumed for all other nontarget organisms within that taxon. For instance if a mixture results in synergistic toxicity to a target insect, like an aphid, then that synergy needs to be assumed for all insects and possibly all other invertebrates in the ecological risk assessment unless available data indicate otherwise. This would be consistent with EPA’s current use of surrogate species to estimate toxicity to other species within the same taxon for the human health and ecological risk assessments. This is one way that the EPA can begin to take into account mixture toxicity given the extensive data gaps that are currently present.

Conclusions

The human health and ecological risk assessments are a key part of the EPA’s pesticide-approval process; without them the agency cannot justifiably conclude that a pesticide can be used without unreasonable harm. When relevant data are not included in the risk assessment, and nonconservative assumptions are made about mixture toxicity, it diminishes the process and ultimately underestimates harm to humans and the environment.

The patent applications identified in this analysis are just the tip of the iceberg. The patent landscape on pesticide mixtures is vast and in no way limited to pesticides that are sold together in formulations. In fact, the implications of this analysis should extend far beyond that of multi-ingredient product approval. The entire pesticide-approval process is designed to narrowly assess the toxicity of individual active ingredients one at a time; yet when most of these active ingredients are being routinely co-applied on agricultural fields across the country, the initial analyses that were done are no longer relevant to real-world

exposure scenarios and are not an appropriate estimate of true risk.

This analysis highlights the shortcomings of such a narrow approach. Since mixture toxicity is such a low priority for the EPA, it is no surprise that relevant information was missed for so long. Clearly pesticide synergy is not a rare occurrence and should no longer be treated as such. The EPA must take into account relevant patent data and other lines of evidence and fundamentally alter its approach to assessing pesticide mixtures.

Appendix A

Methodology of Product Search

We used the EPA's Pesticide Product Label System database to conduct our search.³⁰ In the "company name" search box we searched for "Bayer," "Dow Agrosiences LLC," "Monsanto Company" and "Syngenta Crop Protection," which identified 685, 369, 176 and 539 products respectively. These are all of the pesticide products with "active" status for these four companies as of June 23, 2016 (a total of 1769). To identify the products that had their initial approval in the last six years *and* had multiple active ingredients, we found all active products that had a date on or after June 23, 2010 in the "current status" column. We then searched the pesticide labels of each of those products. If the label indicated two or more active ingredients were present in the product, it was included in our analysis. Of the 1769 active products for these companies, 140 had multiple active ingredients and were first approved by the EPA in the past six years. All of these products are listed in Appendix B.

Methodology of Patent Search

To identify all applicable patent applications, we used a multi-layered search strategy. First, we used the search engines from Google Patents,³¹ FreePatentsOnline³² and the USPTO³³ to do simple keyword searches. The common names of each pesticide were searched concomitantly with the words "synergy," "synergistic" or "synergism." We found many relevant patents using this strategy, but quickly became aware of the limitations of doing a simple keyword search. Many patent applicants do not refer to pesticides by their common name but instead use a common core structure along with various possible side groups to describe the chemicals they want to patent. In order to identify these patents, we used a search engine called SureChEMBL.³⁴ This allows the user to search patent applications for the chemical structure of the pesticide in conjunction with keywords. In addition, we used SciFinder³⁵ to search patent applications by the pesticide's Chemical Abstracts Service (CAS) number and filtered results by other pesticides mentioned in the patent or by the word "synergistic."

All of the patents we identified were further scrutinized. First, any patent application that was not

submitted to the USPTO was discarded. This is because many of the patent applications submitted to other countries that we identified were in a language other than English; however, we note that this discarded information could likely be useful to the EPA. We then went through each of the identified patents and verified that claims of synergy were made for at least two of the active ingredients in the product. If it was stated anywhere in the patent application that a mixture of chemicals acted synergistically to produce toxicities to any organism, that patent was used in our analysis. However, we note that a strong majority of patent applications also contained experimental evidence of synergy.

Notes were taken on each patent included in our analysis, including:

- 1) The company that was listed as the applicant or assignee of the patent application and whether this was different from the registrant of the product.
- 2) The taxa of the organism(s) for which synergy was claimed (plants, insects, fungi, nematodes).
- 3) If there was a possible difference in stereoisomer content of the chemicals in the pesticide product and the patent application. Since lambda-cyhalothrin is a mixture of enantiomers, one of which is gamma-cyhalothrin, any claims of synergy for one was assumed for the other. Similarly, since mefenoxam is one of the two enantiomers that are present in metalaxyl, any claims of synergy for one was assumed for the other.
- 4) If any experimental evidence of synergy was provided in the patent application as well as the magnitude of the synergy as measured by the Colby equation.³⁶ If experimental data were provided in the application and a Colby analysis was performed, the extent of synergy (low, medium and high) was noted for each patent application. The observed response (C_{obs}) and the expected response (assuming no interaction) (C_{exp}) were used to make this determination. If the difference of C_{obs} and C_{exp} was less than 10, that was considered low synergy. If the difference of C_{obs} and C_{exp} was between 10 and 20, that was considered medium synergy. And if the difference of C_{obs} and C_{exp} was greater than 20 or if C_{obs}/C_{exp} was greater than 2, then that was considered high synergy. Also, if experiments were performed but no data were provided, or if experimental data were given but no Colby equation was done, we took note of that as well (Appendix B).

Appendix B

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
7/14/2010	D	62719-616	penoxsulam; cyhalofop												
7/20/2010	S	100-1369	thiamethoxam; fludioxonil; azoxystrobin; mefenoxam	10496187	3	F	S	10170902	1, 7	F	S				
7/25/2010	B	72155-90	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
7/26/2010	B	72155-91	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
7/26/2010	B	72155-89	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
8/2/2010	B	264-1103	lodosulfuron-methyl-sodium; mesosulfuron-methyl												
8/3/2010	D	62719-617	aminopyralid; metsulfuron methyl	12945099	6	P	D								
8/5/2010	S	100-1366	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/5/2010	S	100-1367	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/6/2010	D	62719-612	penoxsulam; isoxaben												
9/3/2010	S	100-1352	fludioxonil; mefenoxam; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S				
10/14/2010	B	432-1513	trifloxystrobin; triadimefon												
10/29/2010	S	100-1384	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
11/24/2010	S	100-1385	fomesafen; glyphosate												
1/20/2011	B	352-846	aminocyclopyrachlor; chlorsulfuron												
1/20/2011	B	352-848	aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
1/20/2011	B	352-847	imazapyr; aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
2/16/2011	S	100-1389	pinoxaden; fluroxypyr												
3/2/2011	S	100-1396	fomesafen; glyphosate												
3/10/2011	D	62719-630	2,4-D; aminopyralid	13014909	6	P	D								
3/10/2011	D	62719-628	2,4-D; aminopyralid	13014909	6	P	D								
3/11/2011	S	100-1377	azoxystrobin; propiconazole												
3/11/2011	S	100-1378	azoxystrobin; propiconazole												
3/24/2011	S	100-1393	fludioxonil; mefenoxam	8799310	1, 3	F	S								
4/10/2011	D	62719-629	2,4-D; aminopyralid	13014909	6	P	D								
4/12/2011	S	100-1364	chlorothalonil; acibenzolar-S-methyl												
4/12/2011	B	72155-98	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-99	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-100	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-101	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/26/2011	B	72155-104	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
4/29/2011	B	264-1132	clothianidin; Bacillus-firmus I-1582	12936700	3	I, F, N	B								
5/2/2011	B	72155-102	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/2/2011	B	72155-103	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/5/2011	D	62719-637	triclopyr; fluroxypyr												
6/3/2011	S	100-1402	<i>lambda</i> -cyhalothrin; chlorantraniliprole												
6/13/2011	B	72155-105	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
6/15/2011	S	100-1399	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
				14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
6/27/2011	D	62719-640	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
8/12/2011	B	72155-106	2,4-D; isoxaben; mecoprop-p; dicamba	13841457	6	P	B								
8/17/2011	B	264-1134	lodosulfuron-methyl sodium; thienacarbazone-methyl	12824951	6	P	B								

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/19/2011	S	100-1405	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
11/16/2011	S	100-1410	S-metolachlor; mesotrione	14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
12/6/2011	B	264-1135	thiencarbazone-methyl; pyrasulfotole; bromoxynil	12374219	6	P	S								
12/14/2011	S	100-1414	S-metolachlor; mesotrione; atrazine	12824951	4	P	B								
1/11/2012	S	100-1415	azoxystrobin; thiamethoxam	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
1/26/2012	B	432-1519	thiencarbazone-methyl; foramsulfuron; halosulfuron-methyl												
2/1/2012	S	100-1433	azoxystrobin; difenoconazole	13902364	5	P	B	12824951	5	P	B				
2/2/2012	S	100-1427	thiamethoxam; mefenoxam; fludioxonil	10496185	8	F	S								
2/2/2012	S	100-1426	thiamethoxam; mefenoxam; fludioxonil; thiabendazole	13209926	2, 3	F	Bf	8799310	1, 3	F	S				
2/2/2012	B	264-1091	fluopyram; tebuconazole	11563240	6	F, N	S	8799310	1, 3	F	S				
2/2/2012	B	264-1090	fluopyram; trifloxystrobin												
2/2/2012	B	264-1085	fluopyram; pyrimethanil												
2/2/2012	B	264-1084	fluopyram; prothioconazole												
2/7/2012	D	62719-646	acetochlor; atrazine												
2/14/2012	S	100-1429	pinoxaden; fenoxaprop-p-ethyl												
2/15/2012	D	62719-645	clpyralid; aminopyralid	13715230	6	P	D	14102818	6	P	D				
2/22/2012	S	100-1428	difenoconazole; mefenoxam												
4/23/2012	S	100-1436	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/23/2012	S	100-1437	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/27/2012	B	72155-107	metsulfuron-methyl; thiencarbazone-methyl; indaziflam; dicamba	12824951	6	P	B	12506456	3	P	B				
4/30/2012	S	100-1438	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
5/11/2012	B	264-1125	penflufen; clothianidin	11912773	6	I	B								
5/11/2012	B	264-1123	penflufen; prothioconazole	13061976	3	F	B								
5/11/2012	B	264-1122	prothioconazole; penflufen; metalaxyl	10508208	2, 3	F	Bf	12663273	5	F	B				
5/11/2012	B	264-1124	penflufen; trifloxystrobin	12663273	4	F	B								
5/11/2012	B	164-1121	clothianidin; penflufen; trifloxystrobin; metalaxyl	11793763	6	I	B	10486663	6	I	B	12663273	5	F	B
				13209926	2, 3	F	Bf	11912773	6	I	B				
6/20/2012	S	100-1383	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
6/21/2012	S	100-1440	abamectin; thiamethoxam	11028776	7	I	S								
8/2/2012	S	100-1442	S-metolachlor; mesotrione; atrazine	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
8/23/2012	S	100-1449	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
10/31/2012	S	100-1441	chlorothalonil; difenoconazole	12066894	8	F	S								
12/6/2012	S	100-1455	mesotrione; prodiamine	12374195	6	P	S								
1/15/2013	M	71995-57	glyphosate; diquat dibromide												
1/15/2013	M	71995-56	glyphosate; diquat dibromide												
1/15/2013	S	100-1457	abamectin; thiamethoxam; mefenoxam; fludioxonil	11028776	7	I	S	8799310	1, 3	F	S				
1/22/2013	B	432-1528	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
1/23/2013	S	100-1458	<i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
1/30/2013	S	100-1459	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
1/30/2013	S	100-1460	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
3/5/2013	D	62719-655	2,4-D; picloram												
3/7/2013	D	62719-653	2,4-D; picloram												
4/2/2013	D	62719-673	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
4/3/2013	D	62719-671	atrazine; acetochlor												
4/4/2013	D	62719-668	atrazine; acetochlor												
4/4/2013	D	62719-670	atrazine; acetochlor												
6/11/2013	B	432-1527	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
6/12/2013	S	100-1444	thiamethoxam; fludioxonil; difenoconazole	7792845	4	F	S								
6/17/2013	S	100-1470	glyphosate; mesotrione												
6/19/2013	B	72155-110	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
7/22/2013	D	62719-666	methoxyfenozide; spinetoram												
8/8/2013	B	352-845	aminocyclopyrachlor; sulfometuron-methyl; chlorsulfuron												
8/29/2013	D	62719-667	methoxyfenozide; spinosad												
2/3/2014	D	62719-648	cyhalofop; fluroxypyr	12913235	6	P	D								
2/6/2014	S	100-1421	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1422	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1424	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/27/2014	D	62719-679	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	M	524-614	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	S	100-1508	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
4/22/2014	M	524-616	dicamba; glyphosate	13099552	2, 6	P	D	13751021	7	P	M				
5/16/2014	D	62719-680	sulfentrazone; cloransulam-methyl												
5/29/2014	S	100-1527	thiamethoxam; difenoconazole; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				7792845	4	F	S	12278731	6	F	S				
5/30/2014	S	100-1526	difenoconazole; mefenoxam; fludioxonil; sedaxane	8799310	1, 3	F	S	7792845	4	F	S	12278731	6	F	S
6/10/2014	B	264-1168	fenoxaprop-p-ethyl; pyrasulfotole; bromoxynil octanoate; bromoxynil heptanoate												
7/16/2014	S	100-1540	propiconazole; azoxystrobin												
7/29/2014	B	432-1533	foramsulfuron; iodosulfuron-methyl; thiencazone-methyl	13902364	5	P	B	12824951	6	P	B				
9/29/2014	B	264-1170	spirotriamat; imidacloprid	13790375	7	I	B								
10/10/2014	S	100-1555	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
10/15/2014	D	62719-649	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
11/12/2014	B	432-1530	imidacloprid; spirotriamat	13790375	7	I	B								
12/2/2014	S	100-1530	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
12/22/2014	S	100-1549	azoxystrobin; propiconazole; <i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
12/23/2014	S	100-1550	azoxystrobin; acibenzolar-S-methyl												
1/12/2015	S	100-1506	azoxystrobin; difenoconazole	10496185	8	F	S								
1/14/2015	S	100-1554	azoxystrobin; difenoconazole	10496185	8	F	S								
2/6/2015	B	264-1171	imidacloprid; fluopyram												
4/13/2015	M	524-620	acetochlor; fomesafen												
4/21/2015	B	72155-112	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/21/2015	B	72155-113	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/24/2015	S	100-146	atrazine; bicyclopyrone; S-metolachlor; mesotrione	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
4/27/2015	D	62719-689	cloransulam-methyl; flumioxazin												
7/17/2015	B	72155-114	tau-fluvalinate; tebuconazole												
8/5/2015	S	100-1561	sedaxane; mefenoxam; fludioxonil	8799310	1, 3	F	S	12278731	6	F	S				
8/23/2015	S	100-1450	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
8/28/2015	D	62719-685	clopyralid; fluroxypyr; pyroxusulam												

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/8/2015	B	432-1544	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
10/19/2015	S	100-1556	thiamethoxam; fludioxonil; difenoconazole; sedaxane	12306870	2, 6	I	B	7792845	4	F	S	12278731	6	F	S
10/19/2015	S	100-1559	thiamethoxam; mefenoxam; thiabendazole; fludioxonil; sedaxane	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
11/10/2015	B	11556-186	diflubenzuron; permethrin												
12/9/2015	B	264-1182	penflufen; trifloxystrobin; metalaxyl	12663273	5	F	B								
1/6/2016	D	62719-693	acetochlor; mesotrione; clopyralid	12074809	3	P	D								
2/3/2016	S	100-1564	thiamethoxam; difenoconazole; mefenoxam; sedaxane; cytokinin; gibberellic acid; indole butyric acid	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
2/8/2016	S	100-1568	bicyclopyrone; mesotrione; S-metolachlor	12374219	6	P	S								
2/17/2016	B	264-1184	dicamba; tembotrione												
2/24/2016	D	62719-702	penoxsulam; oxyfluorfen	13014869	6	P	D								
4/11/2016	B	432-1583	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
4/12/2016	S	100-1563	thiamethoxam; thiabendazole; sedaxane; mefenoxam; fludioxonil	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
6/16/2016	S	100-1587	fludioxonil; sedaxane; thiamethoxam	12278731	3	F	S	12306870	2, 5	I	B				
6/20/2016	B	432-1537	fluopyram; trifloxystrobin												

Column 1: Date that the product was first approved by the EPA

Column 2: Registrant of the approved product (D=Dow, M=Monsanto, S=Syngenta, B=Bayer)

Column 3: Registration number of the product. Information on products can be found by searching the registration number on the EPA's Pesticide Product Label System found here:

<https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>

Column 4: A list of the active ingredients found in each product

Column 5: The patent application number. Patent applications can be searched by application number on USPTO's Public Pair Portal found here:

<http://portal.uspto.gov/pair/PublicPair>

Column 6: Notes taken on the patent. **For more detailed information see Appendix A**

1 = Stereoisomer content of a pesticide in the product may differ from that analyzed in the patent.

2 = Applicant/assignee of patent application differs from the registrant of the product

3 = No experimental evidence was provided in the patent application

4 = Experimental evidence was provided in the patent application, which indicated low synergy

5 = Experimental evidence was provided in the patent application, which indicated medium synergy

6 = Experimental evidence was provided in the patent application, which indicated high synergy

7 = Experimental evidence was provided in the patent application but no Colby equation was performed

8 = Experiments were said to be performed but data were not provided in the patent application

Column 7: Taxa for which synergistic toxicity is claimed or demonstrated (P=Plants, I=Insects, F=Fungi, N=Nematodes)

Column 8: Applicant/assignee of the patent (D=Dow, M=Monsanto, S=Syngenta, B=Bayer, Du=Dupont, Bf=BASF)

Columns 9-12: Repeat columns 5-8

Columns 13-16: Repeat columns 5-8

References Cited

- ¹ 7 U.S.C. § 136a(c)(5)(C), (D); 40 C.F.R. § 152.112(e).
- ² EPA. Pesticide Registration: Data Requirements for Pesticide Registration. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/data-requirements-pesticide-registration#nto>.
- ³ Cox, C., and Sorgan, M. (2006) Unidentified inert ingredients in pesticides: implications for human and environmental health. *Environ Health Perspect*, 114(12), 1803-1806.
- ⁴ EPA. Pesticide Registration: Pesticide Registration Manual: Chapter 1 - Overview of Requirements for Pesticide Registration and Registrant Obligations. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/pesticide-registration-manual-chapter-1-overview-requirements-pesticide#adjuvants>.
- ⁵ Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L., Scott, J.C., Stackelberg, P.E., Thelin, G.P., Wolock, D.M. (2006) Pesticides in the Nation's Streams and Ground Water, 1992-2001: U.S. Geological Survey Circular 1291. Available at: <http://pubs.usgs.gov/circ/2005/1291/>.
- ⁶ Lydy, M., Belden, J., Wheelock, C., Hammock, B., Denton, D. (2004) Challenges in regulating pesticide mixtures. *Ecology and Society* 9(6): 1. Available at: <http://www.ecologyandsociety.org/vol9/iss6/art1/>.
- ⁷ EPA. (2000) Supplementary guidance for conducting health risk assessment of chemical mixtures. EPA/630/R-00/002. Accessed 6/21/2016. Available at: <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=20533>.
- ⁸ Respondents' Motion for Voluntary Vacatur and Remand filed in *Natural Resources Defense Council, Inc. v. U.S. EPA*, No. 14-73353 (consolidated with 14-73359), ECF Dkt. No. 121 (filed November 24, 2015 9th Cir.).
- ⁹ 35 U.S.C § 103.
- ¹⁰ Instead of identifying all of the products that were approved in the last six years that have multiple active ingredients, we decided to focus our analysis on just four companies. Our reasoning is that the EPA's pesticide product label database is of limited utility. The only search terms are "product name," "company name" or "EPA registration number." The only way to identify all products approved by date is to search by company, so we focused our analysis on the major players in the agrichemical business.
- ¹¹ The 47 USPTO patent application numbers are: 13014909, 11028776, 12074809, 14172201, 12945099, 12675156, 8930901, 12066894, 9968175, 13715230, 14102818, 12936700, 11793763, 13209926, 10486663, 11628145, 12913235, 9968173, 12633063, 14215205, 13099552, 13751021, 10496185, 10170902, 10496187, 7792845, 12147853, 14567574, 12506456, 13841457, 8799310, 11028769, 11563240, 14183671, 12374195, 12374219, 11912773, 12663273, 13061976, 14026902, 13014869, 10508208, 12278731, 13790375, 12306870, 13902364 and 12824951.
- ¹² Usage information was collected from the USGS National Water-Quality Assessment (NAWQA) Program. Pesticide National Synthesis Project – annual pesticide use maps 2013. Available here: https://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php. High use ingredients (defined as more than one million pounds active ingredient used in the agricultural sector per year in the U.S.) covered by the identified patent applications include: 2,4-D, thiamethoxam, acetochlor, clopyralid, atrazine, mesotrione, S-metolachlor, chlorothalonil, imidacloprid, clothianidin, dicamba, glyphosate, azoxystrobin, bromoxynil.
- ¹³ EPA. Regulations.gov docket number EPA-HQ-OPP-2014-0355. Bicyclopyrone: New Proposed Tolerance in/on Corn commodities and a New Proposed Import Tolerance in/on Sugarcane. Available at: <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2014-0355>.
- ¹⁴ EPA. (2015) Bicyclopyrone: Response to Public Comments on EPA's "Proposed Registration of the New Active Ingredient Bicyclopyrone." Document ID: EPA-HQ-OPP-2014-0355-0076. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0076>.
- ¹⁵ EPA. Memorandum. (2015) Environmental Fate and Ecological Risk Assessment for Use of the New

Herbicide Bicyclopyrone (NOA449280). Document ID: EPA-HQ-OPP-2014-0355-0015. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0015>.

¹⁶ The United Soybean Board. Take Action. Herbicide Classification Chart. Accessed 6/22/2106. Available at: <http://takeactiononweeds.com/wp-content/uploads/herbicide-classification-chart-2016.pdf>.

¹⁷ Abendroth, J.A., Martin, A.R., Roeth, F.W. (2006) Plant Response to Combinations of Mesotrione and Photosystem II Inhibitors. *Weed Technology*, 20(1), 267-274.

¹⁸ Woodyard, A., Bollero, G., Riechers, D. (2009) Broadleaf Weed Management in Corn Utilizing Synergistic Postemergence Herbicide Combinations. *Weed Technology*, 23(4), 513-518.

¹⁹ Sutton, P., Richards, C., Buren, L., Glasgow, L. (2002) Activity of mesotrione on resistant weeds in maize. *Pest Manag Sci*, 58(9), 981-984.

²⁰ Bollman, S.L., Kells, J.J., Penner, D. (2006) Weed Response to Mesotrione and Atrazine Applied Alone and in Combination Preemergence. *Weed Technology*, 20(4), 903-907.

²¹ Hugie, J., Bollero, G., Tranel, P., Riechers, D. (2008) Defining the Rate Requirements for Synergism between Mesotrione and Atrazine in Redroot Pigweed (*Amaranthus retroflexus*). *Weed Science*, 56(2), 265-270.

²² Walsh, M., Stratford, K., Stone, K., Powles, S. (2012) Synergistic Effects of Atrazine and Mesotrione on Susceptible and Resistant Wild Radish (*Raphanus raphanistrum*) Populations and the Potential for Overcoming Resistance to Triazine Herbicides. *Weed Technology*, 26(2), 341-347.

²³ Syngenta. (2015) Acuron Technical Bulletin. Acuron™ corn herbicide defeats tough weeds current products are missing, Page 22. Downloaded on 6/30/2016 from: <http://www.syngentacropprotection.com/prodrender/imagehandler.ashx?ImID=d40b0089-7648-491d-9d4f-c4f1c92d27bb&fTy=0&et=8>. PDF of bulletin is on file with the authors.

²⁴ The Center has initiated litigation challenging the EPA's failure to consider the impacts of this approval on threatened and endangered species. See https://www.biologicaldiversity.org/news/press_releases/2015/pesticides-06-18-2015.html.

²⁵ Dow Agrosciences LLC, Wang, Peng, Huang, Jim X., Dripps, James E., Yu, Alisa Y. (WO2015196339) SYNERGISTIC EFFECT OF SPINETORAM AND METHOXYFENOZIDE FOR CONTROL OF STEM BORER ON RICE. International patent application # PCT/CN2014/080526, filed June 23rd, 2014.

²⁶ USPTO. USPTO Will Begin Publishing Patent Applications. November 27th, 2000. Available at: <http://www.uspto.gov/about-us/news-updates/uspto-will-begin-publishing-patent-applications>.

²⁷ Bayer Cropscience LP, Reid, Byron L, Baker, Robert B, Bao, Nanggang N, Koufas, Deborah A, Kent, Gerald J, Baur, Peter. (Patent # 8,404,260). Synergistic pesticide compositions. USPTO Application number 12/410,840, filed March 25th 2009. This is an example of a patent application that demonstrates synergy between the active ingredient imidacloprid and commonly used inert ingredients.

²⁸ 40 C.F.R. § 159.195(a).

²⁹ 7 U.S.C. § 136d(a)(2).

³⁰ Found here: <https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>.

³¹ Found here: <https://patents.google.com/>.

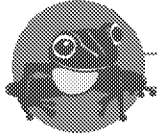
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³⁶ Colby, S.R. (1967) Calculating Synergistic and Antagonistic Responses of Herbicide Combinations. *Weeds*, 15(1), 20-22.



September 12, 2016

Office of Pesticide Programs
Environmental Protection Agency Docket Center (EPA/DC)
EPA West Building, Room 3334
1301 Constitution Ave NW
Washington, DC 20460-0001

**Re: Comments on EPA Opening the Registration Review Docket – Dicamba
(Docket #: EPA-HQ-OPP-2016-0223)**

Please accept the following comments on behalf of the Center for Biological Diversity (“Center”) in response to the Environmental Protection Agency’s (“EPA”) opening the registration review docket for dicamba under the Federal Insecticide, Fungicide, and Rodenticide Act (“FIFRA”). The Center previously submitted comments on a new use of dicamba on herbicide-tolerant cotton and soybean (Docket #: EPA-HQ-OPP-2016-0187) and incorporates those comments by reference.

The Center for Biological Diversity (“Center”) is a non-profit environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has more than one million members and online activists dedicated to the protection and restoration of endangered species and wild places. The Center has worked for twenty-six years to protect imperiled plants and wildlife, open space, air and water quality, and overall quality of life. The Center’s Environmental Health Program aims to secure programmatic changes in the pesticide registration process and to stop toxic pesticides from contaminating fish and wildlife habitats. We appreciate the opportunity to provide comment.

Before the EPA can make a supportable decision to authorize additional uses of this pesticide, it must first accomplish all of the following:

1. Comply with duties under Section 7 of the Endangered Species Act (ESA),¹ including completion of consultation.

As a separate, discretionary action that may affect endangered and threatened species, the EPA cannot approve new uses prior to the completion of consultations with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (“the Services”). Without such consultation, the EPA cannot satisfy its duty to insure that its action does not jeopardize the continued existence of imperiled species across the country or adversely modify or destroy their critical habitat. Moreover, unless and until the EPA completes ESA consultation, any taking of protected species from the use of this pesticide is unlawful.

Section 7(a)(2) of the Endangered Species Act (“ESA”) requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary . . . to be critical.”² Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.³ Indeed, the EPA’s recently finalized policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.⁴ The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.⁵ The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement.”⁶ Accordingly, the EPA must consult with the Services on its continuing and ongoing authority over this pesticide to satisfy its duty to insure that its use will not jeopardize or adversely modify protected species or their critical habitat well *before* it proposes a registration review decision. *See* Endangered Species Act Consultation Obligations for Pesticide Approvals by the Environmental Protection Agency (enclosed).

The EPA must consult on all synergistic and cumulative uses. The EPA must insure that all uses of this pesticide do not jeopardize species protected by the ESA or adversely modify or destroy their critical habitat, including uses with other ingredients or other pesticides. Absent

¹ 16 U.S.C. § 1536.

² 16 U.S.C. § 1536(a)(2) (emphasis added).

³ 50 C.F.R. § 402.14(a).

⁴ http://www.epa.gov/oppfead1/cb/csb_page/updates/2013/esa-regreview.html

⁵ 50 C.F.R. § 402.14(a).

⁶ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

information or data to determine whether dicamba will act synergistically with other ingredients, such uncertainty requires that the EPA decline to re-register any end use products containing more than one active ingredient and prohibit tank mixing on the labels.

At a minimum, where a product may affect listed species, all product labels must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁷

2. Require that that the registrant provide all necessary data and studies.

The EPA must have substantial evidence to re-register this pesticide. To do so, the EPA must require all necessary data and studies, including, but not limited to any previously identified data or study gaps, additional studies to evaluate effects on pollinators in accordance with the *Guidance for Assessing Pesticide Risks to Bees*,⁸ information concerning estrogen or other endocrine disruption effects,⁹ and any information that this pesticide or products containing this pesticide may have synergistic effects.

3. Incorporate necessary factors into evaluation and any proposed decision.

These factors should include the following, at a minimum:

- a. effects on species listed as protected under the ESA and their critical habitat,
- b. effects on pollinators and other beneficial insects,
- c. effects on human health or environmental safety concerning endocrine disruption, and
- d. any additive, cumulative or synergistic effects of the use of this pesticide.

⁷ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

⁸ EPA 2014. *Guidance for Assessing Pesticide Risks to Bees*. Available at https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf

⁹ See 21 U.S.C. §§ 346a(d)(2)(A)(x) and 346a(p).

EPA cannot propose a registration review decision under FIFRA (often described as “interim”) and satisfy its legal duties unless it requires sufficient information and evaluates it for adverse effects before reaching any conclusions.

Congress tasked the EPA with regulation of pesticides for safe use. FIFRA authorizes EPA to register a pesticide only upon determining that the pesticide “will perform its intended function without unreasonable adverse effects on the environment,” and that “when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse effects on the environment.”¹⁰ The statute defines “unreasonable adverse effects on the environment” to include “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.”¹¹ The EPA cannot meet this standard without requiring, evaluating and considering all information that causes adverse effects from the additional use of this pesticide. *Pollinator Stewardship Council v. U.S. E.P.A.*, Case No. 13-72346, Dkt. No. 58-1 at 6, 2015 WL 5255016, *1.

4. Place appropriate restrictions on uses to avoid and minimize adverse effects.

The EPA has broad authority to restrict uses and place strong mitigation language on labels to avoid adverse effects and when there is uncertainty.

5. The EPA Needs to Take Into Account Real-world Scenarios.

The EPA often claims that it is acting conservatively by using the maximum labeled use rates when estimating exposure to plants and animals. These upper-level exposure scenarios, however, do not take into account accidental spills and illegal uses of the pesticide.

A recent survey of farmers in Missouri indicated that less than half -- only 43 percent -- actually read the label each time they use pesticides.¹² Sixteen percent only read the label half the time or less and 1.2 percent have never read the label at all. Pesticide labels also have wind speed requirements that are meant to reduce drift and are used in EPA’s risk assessment process to estimate off-site exposure. Four percent of pesticide applicators never checked the wind speed before application and 40 percent of applicators checked wind speed by looking at trees, a very unreliable form of measurement that is often inaccurate.

Therefore, the ever-present possibility of an accidental spill indicates that this is a reasonably foreseeable event that should be accounted for when estimating peak exposure concentrations. In

¹⁰ 7 U.S.C. § 136a(e)(5)(C), (D); 40 C.F.R. § 152.112(e).

¹¹ 7 U.S.C. § 136(bb).

¹² Randall. July 13th, 2016. State news. *57 percent of those applying pesticides in Missouri do not read label instructions*. Available at: <http://www.kttm.com/57-percent-of-those-applying-pesticides-in-missouri-do-not-read-label-instructions/>.

addition, the small amount of data that are available on label compliance indicate that it is unreasonable to assume that pesticides are always applied in accordance with the label. We feel that when communicating findings to a risk manager, the EPA no longer refer to its use of maximum labeled rates as “conservative” or accurately estimating peak exposures that may occur.

6. The EPA needs to take into account increased use of dicamba in its risk assessments.

The EPA’s risk assessment approach is not designed to analyze risk due to increased total usage of a pesticide compared to current levels. It is simply designed to estimate exposure to a single chemical based on labeled usage rates on specific crops. This exposes one of the great shortcomings in EPA’s risk assessment approach – it is very short sighted. It takes a narrow approach of assessing risk without taking into account the bigger picture of total usage of a particular pesticide or combined usage of multiple pesticides. Therefore, risk is typically underestimated and potential increases in total pesticide usage are not accurately assessed for potential harms.

The EPA recognized this when proposing to register dicamba for use on dicamba-resistant cotton and soy and stated that “[a]lthough the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications.”¹³ And, “[t]hough the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans.”¹⁴

Dicamba use is on the rise and if the EPA approves the “new use” of dicamba on dicamba-tolerant cotton and soybeans it will result in an even greater increase.^{15,16} Monsanto did an

¹³ EPA. Memorandum. Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). Docket ID: EPA-HQ-OPP-2016-0187-0008.

¹⁴ EPA. Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean. Docket ID EPA-HQ-OPP-2016-0187-0016.

¹⁵ EPA. Memorandum. Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 8770 I). Docket ID EPA-HQ-OPP-2016-0187-0005. Page 36.

¹⁶ Mortensen, DA, Egan, JF, Maxwell, BD, Ryan, MR, Smith, RG. Navigating a Critical Juncture for Sustainable Weed Management. *BioScience* (2012) 62 (1): 75-84. doi:10.1525/bio.2012.62.1.12. and Bohnenblust, EW, Vaudo,

analysis on the possible future increase in use of dicamba for USDA when applying for deregulation of genetically engineered (“GE”) dicamba/glyphosate resistant soybean and cotton. Monsanto predicted that annual commercial dicamba use on soybeans would increase from 233,000 pounds in 2011 to 20.5 million pounds at the time of peak (40%) GE crop adoption.¹⁷ This is a nearly 100-fold increase in dicamba usage just on soybean and could be even higher if these GE crops are more widely adopted. Similar projections were made for dicamba use on cotton from 364,000 pounds applied annually in 2011 to 5.2 million pounds at the time of peak (50%) adoption.¹⁸ Assuming peak adoption of dicamba resistant soybean and cotton would occur in the next 3-4 years, the U.S. is looking at a more than 25 million pound increase in dicamba usage for these two crops by 2020.

Although this is likely an underestimate, as crop adoption rates will likely be much higher and current labels actually urge users to spray higher than typical rates to slow weed resistance, it is a starting point for the EPA to begin to analyze the effects of total pesticide load on human and environmental health. This increase in dicamba usage would not likely displace other herbicide use. The EPA needs to view registration decisions as not only a way to analyze the effects of labeled pesticide usage, but also as a way to ensure that total pesticide use does not increase. The EPA could take this into account in the cost-benefit analysis by analyzing the associated costs of labeled pesticide use as well as the costs associated with total pesticide load in the environment.

There are many parallels here with what happened with glyphosate in the 1990’s. In 1993, the EPA re-registered glyphosate with the finding that labeled use of glyphosate would not cause unreasonable adverse effects on the environment. Of course, a couple of years later the widespread adoption of “Roundup Ready” GE crops resulted in an exponential increase in glyphosate use from around 10 million pounds to around 300 million pounds per year in 25 years.¹⁹ This resulted in many unforeseen environmental problems, most notably by playing a large role in the dramatic decline of the Monarch butterfly. The rapid rise in glyphosate has destroyed Monarch habitat across most of the Midwest and the Monarch is currently being considered for a “threatened” listing under the Endangered Species Act. Glyphosate’s affect on the Monarch was not even discussed in the 1993 ERA for glyphosate. But it happened. There are

AD, Egan, JF, Mortensen, DA, Tooker, JF. Effects of the herbicide dicamba on nontarget plants and pollinator visitation. *Environ Toxicol Chem.* (2016) 35(1): 144-51. doi: 10.1002/etc.3169.

¹⁷ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS appendix, Table 4-9 and page 4-16.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁸ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS Appendix, Table 4-12 and page 4-19.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁹ USGS. *U.S. Geological Survey: Pesticide National Synthesis Project, pesticide use maps-glyphosate.* 2014. [Accessed on 09/12/2016]; Available from: https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2014&map=GLYPHOSATE&hilo=L&disp=Glyphosate.

two reasons for this: 1) the glyphosate ERA did not analyze indirect effects, like those on the milkweed plant that the Monarch is completely reliant on and 2) the EPA did not analyze how such a quick increase in total glyphosate usage would affect the environment. In its dicamba analysis, the EPA needs to fix these two shortcomings in its ERA process and accurately analyze how the inevitable increase in dicamba load in the environment, in combination with glyphosate, will affect human health and the environment.

7. The EPA needs to assess the enhanced toxicity of pesticide mixtures.

The EPA has made no mention of whether it intends to finally do a robust mixture analysis in the upcoming registration review docket. It has long been the EPA's policy to not do a mixture analysis because it's just too darn hard. Yet there is never any mention that this decision essentially results in the default assumption that all mixtures involving dicamba have the exact same toxicity as dicamba alone, a completely scientifically-unjustified assumption. The EPA is constantly saying that there are never enough data and that they lack the methodology to do a robust analysis. But the agency completely ignores the fact that by approving so many multi-ingredient formulations and allowing countless numbers of tank mixtures to occur, it is essentially enabling the existence of all of these mixtures without any data whatsoever that it can be done safely. These are not the actions of an agency that is confident in its abilities to protect the health of humans and the environment; these are the actions of an agency that is in way over its head.

The Center for Biological Diversity recently released a report²⁰ analyzing an unconventional new source of much needed data – patent applications. When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant. For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

We conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta). Our key finding was that 69 percent of these products (96 out of 140) had at least one patent application

²⁰ Donley, N. (2016). Toxic Concoctions: How The EPA Ignores The Dangers Of Pesticide Cocktails. Retrieved from The Center for Biological Diversity website: http://www.biologicaldiversity.org/campaigns/pesticides_reduction/pdfs/Toxic_concoctions.pdf. Submitted to the docket with comment letter.

that claimed or demonstrated synergy between the active ingredients in the product.

There were 11 multi-ingredient products containing dicamba that were approved in the past six years from these four companies.²¹ Of those 11, ten have evidence of synergy between the active ingredients in the product. The identified patent applications in our report found synergistic toxicity to plants from the combinations of:

- 1) Dicamba and glyphosate (U.S. patent application numbers 13099552 and 13751021)
- 2) Dicamba and penoxsulam (U.S. patent application number 14026902)
- 3) Dicamba and Isoxaben/indaziflam (U.S. patent application numbers 13841457 and 12506456)

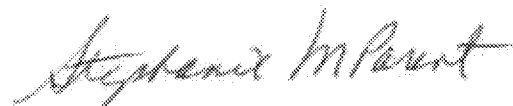
None of these patent applications were discussed in any documents in the docket despite being directly relevant to the analysis at hand. Since most products that contain dicamba were approved more than six years ago, our analysis would not have identified other patent applications or studies that may be relevant to other dicamba products.

This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them.

Therefore, in order to be compliant with FIFRA, the EPA must do an analysis of mixture toxicity with mixtures containing dicamba before a re-registration decision can be made.

If the EPA does not think that it has the proper methodology in place to do this analysis, prohibiting the co-application of certain pesticides with dicamba through label changes and cancelling certain products that contain these mixtures is another way the EPA can ensure that any registration decision is compliant with FIFRA. Otherwise, the EPA will not be able to conclude that the continued use of dicamba will not have unreasonable adverse effects on the environment.

Respectfully submitted,



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²¹ *Id.* at Appendix B



ENDANGERED SPECIES ACT CONSULTATION OBLIGATIONS FOR PESTICIDE APPROVALS BY THE ENVIRONMENTAL PROTECTION AGENCY

I. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on Pesticide Approvals.

Section 7(a)(2) of the ESA requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary... to be critical.”²² Under Section 7(a)(2), the EPA must consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service (collectively the “Services”) to determine whether its actions will jeopardize listed species’ survival or adversely modify designated critical habitat, and if so, to identify ways to modify the action to avoid that result.²³ The consultation requirement applies to any discretionary agency action that may affect listed species.²⁴ Because the EPA may decline to approve pesticides and uses, its decision represents a discretionary action that clearly falls within the ESA’s consultation requirement.²⁵

The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.²⁶ Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.²⁷ Indeed, the EPA’s policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.²⁸ The Services define “may affect” as “the appropriate conclusion when a proposed action may pose *any* effects on listed species or designated critical habitat.”²⁹ This inquiry even includes beneficial effects. The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character,

²² 16 U.S.C. § 1536(a)(2) (emphasis added).

²³ 50 C.F.R. § 402.14.

²⁴ *National Association of Home Builders v. Defenders of Wildlife*, 551 U.S. 644 (2007).

²⁵ See *Washington Toxics Coalition v. EPA*, 413 F. 3d 1024, 1032 (9th Cir. 2005) (“even though EPA registers pesticides under FIFRA, it must also comply with the ESA when threatened or endangered species are affected.”).

²⁶ 50 C.F.R. § 402.14(a).

²⁷ 50 C.F.R. § 402.14(a).

²⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013) at p. 8

²⁹ U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998, *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* (hereafter CONSULTATION HANDBOOK) at xvi (emphasis in original).

triggers the formal consultation requirement.”³⁰ For this initial stage of review, exposure to a pesticide does not require that effects reach a pre-set level of significance or intensity to trigger the need to consult (e.g. effects do not need to trigger population-level responses). As the Services’ joint consultation handbook explains, an action agency such as the EPA may make a “no effect” determination, and thus avoid undertaking informal or formal consultations, only when “the action agency determines its proposed action will not affect listed species or critical habitat.”³¹

Because the use of these pesticide formulations and products “may affect” listed species and “may affect” the critical habitat of listed species, the EPA must consult with the Services regarding its pesticide approvals in order to comply with the ESA.

Fortunately the National Academy of Sciences (“NAS”) has provided guidance regarding the obligations of EPA and other wildlife agencies in analyzing pesticide approvals under the ESA. The NAS committee provided a report to the EPA and Services in April of 2013 providing specific recommendations relating to the use of “best available data,” methods for evaluating sublethal, indirect, and cumulative effects; the state of the science regarding assessment of mixtures and pesticide inert ingredients; the development, application, and interpretation of results from predictive models; uncertainty factors; and what constitutes authoritative geospatial and temporal information for the assessment of individual species, habitat effects and probabilistic risk assessment methods.³²

While the NAS report outlines areas for all three agencies to improve, the NAS report made several significant conclusions about the current ecological risk assessment process and its use of risk quotients (“RQs”), including:

- The EPA “concentration-ratio approach” for its ecological risk assessments “is ad hoc (although commonly used) and has unpredictable performance outcomes.”³³
- “RQs are not scientifically defensible for assessing the risks to listed species posed by pesticides or indeed for any application in which the desire is to base a decision on the probabilities of various possible outcomes.”³⁴
- “The RQ approach does not estimate risk...but rather relies on there being a large margin between a point estimate that is derived to maximize a pesticide’s environmental concentration and a point estimate that is derived to minimize the concentration at which a specified adverse effect is not expected.”³⁵

³⁰ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

³¹ CONSULTATION HANDBOOK at 3-13.

³² National Academy of Sciences 2013. *Assessing Risks to Endangered and Threatened Species from Pesticides* (hereafter NAS REPORT), Committee on Ecological Risk Assessment under FIFRA and ESA Board on Environmental Studies and Toxicology Division on Earth and Life Studies National Research Council (April 30, 2013).

³³ *Id.* at 107.

³⁴ *Id.* at 11.

³⁵ *Id.*

- “Adding uncertainty factors to RQs to account for lack of data (on formulation toxicity, synergy, additivity, or any other aspect) is unwarranted because there is no way to determine whether the assumptions that are used overestimate or underestimate the probability of adverse effects.”³⁶

According to the NAS, the EPA concentration-ratio approach contrasts sharply with a probabilistic approach to assessing risk, which the NAS describes as “technically sound.” The NAS’s underlying conclusion is that EPA should move towards a probabilistic approach based on population modeling, an approach that the NMFS already utilizes.³⁷ The NAS also recommends that the FWS move towards a probabilistic approach in its consultations.

Following the publication of the NAS report, the agencies have developed two policy documents to guide consultations on pesticide review and approvals moving forward: (1) *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes*,³⁸ and (2) *Interim Approaches for National-level Pesticide Endangered Species Act Assessments Based on Recommendations of the National Academy of Science April 2013*.³⁹ The agencies made clear at a November 15, 2013 public meeting that these new procedures and approaches would be “day forward” in their implementation.⁴⁰ Accordingly, approvals of pesticides and uses *must* follow these new *Interim Approaches* and comply with the requirements of the ESA.

A. Completion of Step One under Interim Approaches

As laid out in the National Academy of Sciences and *Interim Approaches* guidance, the risk assessment and consultation process should follow three steps.⁴¹ These steps generally follow the three inquiries of the ESA consultation process: (1) the “no effect”/ “may affect” determination (2) the “not likely to adversely affect”/ “likely to adversely affect” determination (3) the jeopardy/no jeopardy and adverse modification/no adverse modification of critical habitat determination. Step One generally follows the requirements of the ESA and will in most cases identify those species at risk from pesticides that need additional review through the informal and formal consultation process. At Step One, the EPA must gather sufficient data to complete the following two related inquiries: (1) the EPA must determine whether pesticide use areas will overlap with areas where listed species are present, including whether a use area overlaps with any listed species’ critical habitat (2) the EPA must determine whether off-site transport of pesticides will overlap with locations where listed species are present and/or critical habitat is designated. Off-site transport must include considerations of downstream transport due to runoff

³⁶ *Id.*

³⁷ *Id.* at 107.

³⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013).

³⁹ Available at <https://www.epa.gov/sites/production/files/2015-07/documents/interagency.pdf>

⁴⁰ INTERAGENCY APPROACH FOR IMPLEMENTATION OF NATIONAL ACADEMY OF SCIENCES REPORT: ASSESSING RISKS TO ENDANGERED AND THREATENED SPECIES FROM PESTICIDES, Public Meeting Silver Spring NOAA Auditorium (Nov. 15, 2013).

⁴¹ NAS REPORT at 37-38.

as well as downwind transport due to spray drift when the best available science indicates such transport is occurring.⁴²

What the EPA should do to meet the legal requirements of the ESA is use the best available spatial data regarding the pesticide use patterns and the distribution and range of listed species to determine whether a pesticide's use overlaps with species, and then make a "may affect"/"no effect" determination. The Fish and Wildlife Service ECOS website provides GIS-based data layers for each listed species with designated critical habitat.⁴³ These maps are scalable and can achieve the precision needed to make accurate effects determinations regarding whether a pesticide will have "no effect" or "may affect" a listed species and are certainly accurate enough to make determinations as to whether the use of a pesticide represents adverse modification of critical habitat. Figure One provides an overlay map from ECOS of all critical habitat that has been designated for listed species thus far.

Other sources provide additional data on the distribution and life history of threatened and endangered species. NatureServe provides detailed life history information, including spatial distribution, for native species across the United States.⁴⁴ In addition, many State governments collect detailed information on non-game species through their State Wildlife Action Plans.⁴⁵ In short, there are many sources of data that can provide EPA with the detailed information it needs to conduct an effects determination for each species. If there is a subset of species where it believes information is still lacking, EPA should make that clear to all stakeholders which species specifically it believes such data are lacking early in the process such that this information can be collected from the Services and other sources.

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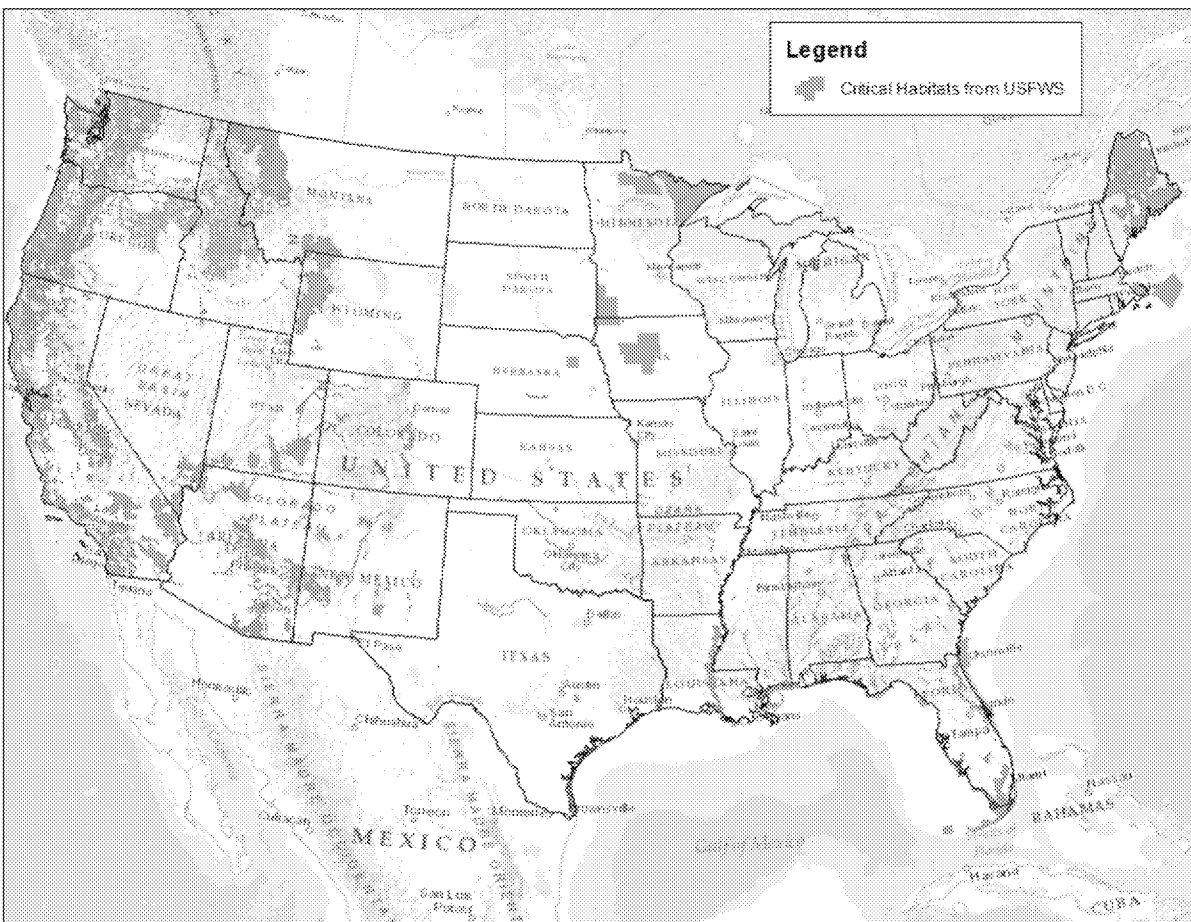
⁴² The Center acknowledges that in many areas, atmospheric transport is difficult to model and assess. However, in some areas, the impacts of atmospheric transport of pesticides are well understood. A recent study found that a variety of pesticides are accumulating in the Pacific chorus frogs (*Pseudacris regilla*) through atmospheric deposition at remote, high-elevation locations in the Sierra Nevada mountains, including in Giant Sequoia National Monument, Lassen Volcanic National Park, and Yosemite National Park Smalling, K.L., et al. 2013. *Accumulation of Pesticides in Pacific Chorus Frogs (Pseudacris regilla) from California's Sierra Nevada Mountains*, Environmental Toxicology and Chemistry, 32:2026–2034.

⁴³ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁴ NatureServe Get data. <http://www.natureserve.org/getData/index.jsp>

⁴⁵ State Wildlife Action Plans. <http://teaming.com/state-wildlife-action-plans-swaps>

Figure One – Base Composite Map of Critical Habitat in the United States⁴⁶



To make scientifically valid effects determinations, EPA will also need the best available spatial data regarding the use of pesticides. The U.S. Department of Agriculture and the U.S. Geological Survey⁴⁷ collect data on an enormous suite of pesticide active ingredients each year, as do several private organizations. Thus, it should be possible to determine where areas of geographic overlap between species and pesticide usage occur. If empirical data on pesticide use or persistence in the environment is lacking geospatial modeling can be used to determine where pesticide use may overlap with affected endangered species.

With the completion of the problem formulations for Ecological Risk, the EPA should now move quickly to begin the informal consultation process for pesticides, starting with a spatial analysis as envisioned as Step one. If this information is collected and assessed properly, then it should then be relatively straightforward for the EPA to begin to develop geographic restriction on the use of pesticides wherever designated critical habitat for a listed species exists as parts of Step Two and Step Three. However, because not all threatened and endangered species have critical

⁴⁶ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁷ USGS, National Water-Quality Assessment (NAWQA) Program, Pesticide National Synthesis Project, Annual Pesticide Use Maps: 1992-2013, available at <https://water.usgs.gov/nawqa/pnsp/usage/maps/>

habitat, the EPA will also have to collect data on the distribution and range of species that do not yet have critical habitat to determine whether the use of these pesticides will jeopardize any of those species.

B. Label Requirements.

FIFRA requires that the EPA evaluate and reregister a pesticide every 15 years. During that 15 year period, crop distributions change, use patterns for pesticides change, and listed species change. By the time the registration review process is complete several years from now, additional species will almost certainly be protected by the ESA. Of the species currently listed, some may move towards recovery and become more common while others may become even more imperiled.

Product labels must be able to adapt to changing conditions on the ground to ensure that the use of these pesticides do not cause unanticipated adverse impacts that result in levels of take not authorized through the Section 7 consultation process. Fortunately, the EPA has already developed a system that can address impacts to endangered species and that provides for geographically-targeted conservation measures on the ground through its *Bulletins Live! Two* website.⁴⁸ The Center recommends that whenever a pesticide may affect listed species, both as a precautionary matter and as a mechanism to implement any conservation measures that are implemented in the informal and formal consultation process, the EPA use the *Bulletins Live! Two* system to incorporate these measures. Accordingly, all product labels for pesticides affecting endangered species must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁴⁹

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⁴⁸ U.S. Environmental Protection Agency Endangered Species Protection Bulletins.

<http://www.epa.gov/espp/bulletins.htm>

⁴⁹ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

II. The EPA Must Make Defensible “Not Likely to Adversely Affect” and “Likely to Adversely Affect” Determinations as a Prerequisite for Defensible “Jeopardy” and “No Jeopardy” Determinations.

At the informal consultation stage, the EPA must determine whether the use of a pesticide is either “not likely to adversely affect” (“NLAA”) a listed species or is “likely to adversely affect” (“LAA”) a listed species.⁵⁰ The Services define NLAA as “when effects on listed species are expected to be discountable, insignificant, or completely beneficial.” Discountable effects are those that are extremely unlikely to occur and that the Services would not be able to meaningfully measure, detect, or evaluate” because of their insignificance⁵¹ In the context of pesticides, only if predicted negative effects are discountable or insignificant can the EPA avoid the need to enter formal consultations with the Services. This is *not* a high threshold. The EPA is not required to make a determination as to whether exposure to a pesticide results in population level changes in order to request formal consultations. The Center believes that the Step Two approach described is generally compatible with the mandates of the ESA regarding actions that may affect listed species. The one in a million mortality threshold for “likely to adversely affect” reflects the ESA’s and the Consultation Handbook’s requirements. The decision to consider 1) sublethal effects to species, 2) additive, synergistic and cumulative effects of all chemicals and non-chemical stressors present in the pesticide formulation, tank mixture, and the environment, 3) and the fate and action of pesticide degradates at Step Two is also consistent with the ESA’s requirements and represents an important change from the previous EPA approach, in which the EPA was making policy judgments at Step Two as to whether known, adverse, population-level impacts crossed a severity threshold to warrant consultations.

Finally, the Center notes that at Step Three, the formal consultation process, the EPA and Services must consider the environmental baseline as well as all cumulative effects when determining if the approval pesticides, formulations, or uses will jeopardize any threatened or endangered species. The Services define environmental baseline as “the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process.”⁵² Cumulative effects are defined as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.”⁵³ Pesticide consultations must consider the interactions between the active ingredient under review and other pollutants in the present in the environment.

The Food Quality Protection Act of 1996 (“FQPA”) requires EPA to measure risk of a pesticide based on “... available information concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity.” The EPA has

⁵⁰ U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act*. at 3-1.

⁵¹ *Id.* at xv.

⁵² *Id.* at xiv.

⁵³ *Id.* at xiii.

interpreted this to mean that only pesticides with a common mechanism of action be assessed in a cumulative risk assessment. We strongly disagree with this interpretation. First, the term “other substances” can include chemicals other than pesticides and also stressors that are not chemicals, like radiation and climate change. The EPA itself defines cumulative risk as “the combined risks from aggregate exposures to multiple agents or stressors,” where agents or stressors can be chemicals or “may also be biological or physical agents or an activity that, directly or indirectly, alters or causes the loss of a necessity such as habitat.”⁵⁴ Second, the term “common mechanism of toxicity” does not dictate that the EPA only consider agents or stressors with a common mechanism of action. The National Research Council has recommended that the EPA use the endpoint of common adverse outcome rather than common mechanism of action to group agents that could act cumulatively.⁵⁵ As for how this relates to EPA’s duty under the ESA, cumulative risk in the ESA needs to be interpreted very broadly as this piece of legislation is a precautionary document meant to ensure that no harm comes to listed species. Although the EPA interprets the scope of cumulative risk assessments under FQPA to be limited to the common mechanism effect, **there is absolutely no such written or intended limit in the ESA**. The EPA needs to begin discussions on how it will test true cumulative risk, the way it is broadly defined in the ESA, because current metrics and protocols that measure cumulative risk under FQPA are inadequate for the EPA to meet its legal obligations under the ESA.

Pesticide and their residues and degradates do not occur in single exposure situations and many different mixtures of pesticides occur in water bodies at the same time.⁵⁶ The mixtures of these chemicals can combine to have additive or synergistic effects that are substantially more dangerous and increase the toxicity to wildlife.⁵⁷ Thus, to fully understand the ecological effects and adverse impacts, the EPA and the Services must consider the pesticide’s use in the context of *current* water quality conditions nationwide. In particular, the use of pesticides in watersheds that contain threatened or endangered species and where water quality is already impaired could be particularly problematic. Therefore, the agencies must use the best available data to fully inform its ecological risk assessment by considering water quality.

In conclusion, the EPA should move quickly to assemble the needed spatial data to make an informed “no effect” or “may affect” finding for *each* listed species that will likely overlap with the use of these pesticides or come into contact with its environmental degradates. If there is overlap, EPA must at a minimum conclude that the use of these pesticides “may affect” listed species. Where this occurs, EPA has a choice—(1) the EPA can elect to complete an informal consultation through a biological assessment (also known as a biological evaluation), or (2) the EPA can undergo formal consultation with the Services. If EPA completes a biological

⁵⁴U.S. Environmental Protection Agency 2003. Framework for Cumulative Risk Assessment. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/P-02/001F, 2003. Pg. xvii.

⁵⁵ National Research Council (US) Committee on the Health Risks of Phthalates. Phthalates and Cumulative Risk Assessment: The Tasks Ahead. Washington (DC): National Academies Press (US); 2008. Page 4.

⁵⁶ NMFS 2011, *Endangered Species Act Section 7 Consultation Draft Biological Opinion for the Environmental Protection Agency’s Pesticide General Permit for Discharges from the Application of Pesticides* (hereafter Draft BiOp) at 118-119, lines 4209-31; Gilliom, R.J. et al. 2006. *Pesticides in the Nation's Streams and Ground Water, 1992–2001—A Summary*, available at <http://pubs.usgs.gov/fs/2006/3028/>.

⁵⁷ Draft BiOp at 127-129, lines 4471-4515; Gilliom, R.J. 2007. *Pesticides in the Nation's Streams and Ground Water*, Environmental Science and Technology, 413408–3414.

assessment and implements geographically-tailored conservation measures through *Bulletins Live! Two*, it may be able to reach NLAA determinations via the informal consultation process and alleviate the need for formal consultations. In the alternative, the EPA can move directly to formal consultation after making “may affect” determinations for species where the impacts of pesticides are more complex and will take additional expertise to develop sufficient conservation measures. Cumulative effects need to be measured in Steps 2 and 3.

III. EPA and the Services Must Assess the Adverse Impacts on Critical Habitat.

Section 7 of the ESA prohibits agency actions that would result in the “destruction or adverse modification of [critical] habitat.”⁵⁸ This inquiry is separate and distinct from the question as to whether a pesticide approval will result in jeopardy to any listed species. A no jeopardy finding (or a Not Likely to Adversely Affect finding in an informal consultation) is *not* equivalent to a finding that critical habitat will not be adversely modified. While there is much overlap between these two categories (for example, as in *Tennessee Valley Authority v. Hill*⁵⁹ where the proposed agency action to build a dam would both destroy a species’ habitat and kill individual members of the species in the same time) many agency actions do result in adverse modification to critical habitat without causing direct harms to species that do rise to the level of jeopardy.⁶⁰ Indeed, the ESA’s prohibition on “destruction or adverse modification” of critical habitat does not contain any qualifying language suggesting that a certain species-viability threshold must be reached prior to the habitat modification prohibition coming into force.

As three federal circuit courts have made abundantly clear, avoiding a species’ immediate extinction is not the same as bringing about its recovery to the point where listing is no longer necessary to safeguard the species from ongoing and future threats. Therefore, Section 7 requires that critical habitat not be adversely modified in ways that would hamper the *recovery* of listed species.⁶¹ These potent pesticides with known adverse ecological effects have the potential to adversely modify critical habitat by altering ecological community structures, impacting the prey base for listed species, and by other changes to the physical and biological features of critical habitat. Accordingly, the informal consultation must separately evaluate whether these pesticide products and formulations will adversely modify critical habitat regardless of whether these pesticide products jeopardize a particular listed species. For example, if plant communities alongside a water body that has been designated as critical habitat suffer increased mortality, and this then results in increased temperatures or increased sedimentation, that would represent adverse modification of critical habitat. Likewise, if pesticides are toxic to species lower in the food chain, and a threatened or endangered species feeds on those affected prey species, this impact to the food web would represent a clear example of adverse modification to critical habitat.

⁵⁸ 16 U.S.C. § 1536(a)(2).

⁵⁹ 437 U.S. 153 (1978)

⁶⁰ See Owen, D. 2012. *Critical Habitat and the Challenge of Regulating Small Harms*. Florida Law Review 64:141-199.

⁶¹ See *Gifford Pinchot Task Force v. FWS*, 378 F.3d 1059, 1069-71 (9th Cir. 2004) (finding a FWS regulation conflating the requirements of survival and recovery to be unlawful); see also *N.M. Cattle Growers Ass’n v. FWS*, 248 F.3d 1277, 1283 n.2 (10th Cir. 2001); *Sierra Club v. FWS*, 245 F.3d 434, 441-42 (5th Cir. 2001)

EPA's evaluation must address impacts to critical habitat even if the direct effects on listed species fall below the NLAA or jeopardy thresholds. The Center recommends that the EPA design conservation measures—and implement those measures using *Bulletins Live! Two*—specifically to protect critical habitat of listed species from exposure to pesticides, and where appropriate, prohibit its use altogether in critical habitat where necessary. Doing so would provide meaningful, on-the-ground protections for hundreds of listed species, and may in some cases, help the EPA and the Services then reach a defensible NLAA or “no jeopardy” opinion.

IV. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on the Approval of All End-use Product Labels.

Just as the EPA must consult with the Services regarding the reregistration of an active pesticide ingredient, EPA must also consult with the Services regarding the registration or approval of end use and technical pesticide products. Such consultations must also occur at the earliest possible time to ensure that specific product formulations do not result in jeopardy for a listed species or adversely modify critical habitat.

In addition, because end use formulations may result in mixes of the active ingredient with “other ingredients” before application, the EPA must consider during the consultation process the effects of these “inert” or “other” ingredients together with the active ingredient on listed species and set appropriate conservation restrictions accordingly. As noted in *Washington Toxics Coalition v. U.S. Dept. of Interior*, “other ingredients” within a pesticide end product may cause negative impact to listed species even if they are less toxic than the active ingredient being reviewed.⁶² “Other ingredients,” such as emulsifiers, surfactants, anti-foaming ingredients, and fillers may harm listed species and adversely modify critical habitat. Many of the more than 4,000 potentially hazardous additives allowed for use as pesticide additives are environmental contaminants and toxins that are known neurotoxins and carcinogens.⁶³ The EPA has routinely failed to consult with the Services on the registration of “other ingredients,” potentially compounding harms to listed species by allowing such ingredients to be introduced widely into the environment. EPA must, as part of the consultation process, consider the range of potential impacts by using different concentrations and different formulations of the active ingredient, as well as the potential negative impacts of “other ingredients” used in end use products.

The National Academy of Science report recognized that without real-world considerations of where listed species are located, the relative conservation status of listed species, the environmental baseline, and the interaction of pesticides with other active ingredients, pesticide degradates, and other pollutants, the EPA risk assessment process will not be able to make meaningful predictions about which endangered species will be adversely affected. Until the EPA can conduct realistic assessments, it should take a precautionary approach and enter into formal consultations with the Services as outlined in the *Interim Approaches* document.

⁶² 457 F. Supp. 2d 1158 (W.D. Wash 2006).

⁶³ Draft BiOp at 113, lines 4062-68; 120-121, lines 4262-308; 127, lines 4445-4455; Northwest Coalition for Alternatives to Pesticides, et al., Petition to Require Disclosure of Hazardous Inert Ingredients on Pesticide Product Labels. 2006. http://www.epa.gov/opprd001/inerts/petition_ncap.pdf.

FESTF

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August 31, 2016

Ms. Marquee King
USEPA Headquarters
Ariel Rios Building
1200 Pennsylvania Avenue, N. W. - Mail Code: 7509P
Washington, DC 20460

Concerning: Active Ingredient: Dicamba Case number: 0065
Docket number: EPA-HQ-OPP-2016-0223

Dear Ms. King,

In its Registration Review Preliminary Work Plan, EPA has noted that Dicamba has not had a complete endangered species determination performed to allow the Agency to determine whether the uses have “no effect” or “may affect” federally listed species or their designated critical habitats. At such time as an endangered species evaluation is conducted by EPA, the data developed by FESTF, in response to the Agency’s endangered species data requirements, will address species proximity to Dicamba uses.

In June of 2004, March of 2005, October 19, 2007, October 12, 2012, April 22, 2013, and June 1, 2015 the FIFRA Endangered Species Task Force (FESTF, Company Number 73989) submitted its Information Management System (FESTF Information Management System (IMS): Documentation of Structure and Function of IMS 1.1, MRID # 46325901) and documentation of the beta-tested IMS, NatureServe data (FESTF Task Force Information Management System (IMS): Beta-Tested IMS 2.0 and Access to NatureServe Data - Final Report, MRID # 46486301), NatureServe Data Evaluation and Review and description of the NatureServe Dataset Licensed by FESTF (MRID #'s 47260101 and 48969501), listed species attribute and aggregated location data (MRID #'s 48969502, 48969506, 49643402), information related to the proximity of listed species to pesticide use sites (MRID #'s 48969503, 48969504, 48969505 and 49272701), and an evaluation of and access to a licensed dataset containing the spatial locations of golf courses (MRID # 49643403). Additionally, FESTF is developing maps for each federally listed species utilizing FESTF’s aggregated species location data. The species maps are being developed in three phases; Phase 1 maps were submitted on February 20, 2015 (MRID # 49575201), Phase 2 maps were submitted on June 1, 2015 (MRID # 49643401) and Phase 3 maps were submitted on March 24, 2016 (MRID # 49880801). These data fulfill the data requirements spelled out in Pesticide Registration Notice 2000-2 and provide the best available data necessary to support the analysis of Dicamba use and listed species locations and potential exposure.

MEMBER COMPANIES

ADAMA Agricultural Solutions, Ltd.
Albaugh, LLC
AMVAC Chemical Corp.
BASF Corp.
Bayer CropScience

Dow AgroSciences, LLC
DuPont Crop Protection
FMC Corp., Ag. Products
Gowan Company, LLC
ISK Biosciences Corp.

MacDermid Agricultural Solutions, Inc.
Monsanto Co.
Nichino America, Inc.
Nippon Soda Co., Ltd.
Nissan Chemical Industries, Ltd.

Nufarm Americas, Inc.
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The technical registrants, as identified on the fact sheet included in the Registration Review work plan, Monsanto Company, DuPont, BASF, Syngenta, Albaugh, MacDermid Agricultural Solutions, Inc., as the parent company for Arysta LifeScience North America, which are FESTF members and are entitled to rely on FESTF data (See Attachment A for our current list of members and companies who have reached an agreement allowing reliance on FESTF data submissions).

Sincerely,

(for)

Dan Campbell

Administrative Chairperson, FESTF

Chair, FESTF Administrative Committee

FIFRA Endangered Species Task Force, L.L.C.

cc: Joy Honegger, Monsanto Company
Richard Ambrose DuPont Crop Protection
Jeffrey Birk, BASF Corporation
Dan Campbell, Syngenta Crop Protection, Inc.
Morris Gaskins, Albaugh, LLC
Melinda Bowman, MacDermid Agricultural Solutions, Inc.
Grant Rowland, USEPA

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ATTACHMENT A

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September 13, 2016

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Dear Ms. Guilaran,

Please find enclosed Monsanto's comment on the dicamba preliminary work plan, the ecological problem formulation, and human health draft risk assessment Docket ID No. EPA-HQ-OPP-2016-0223.

Sincerely,

Jerry W. Cabbage, Ph.D.
Regulatory Affairs Manager

**COMMENTS OF MONSANTO COMPANY
ON THE DICAMBA AND DICAMBA BAPMA SALT
PRELIMINARY WORK PLAN (PWP)**

EPA-HQ-OPP-2016-0223

Submitted by:
Monsanto Company
800 North Lindbergh Blvd.
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Monsanto Comments on Dicamba and Dicamba BAPMA Salt

Preliminary Work Plan (PWP)

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean	Statement: Executive Summary and 5.4.4 Chronic Dietary Risk Assessment: "...most highly exposed population subgroup is children ages 1-2...42% of the cPAD."	5, 37	Comment: The text, while consistent with the select data presented in the summary table in 5.4.6, does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba. Acute and Chronic Dietary Exposure Assessments of Food and Drinking Water to Support the Use of Dicamba on Dicamba-Tolerant Cotton and Soybean for Amended Section 3 Registration, and Registration of the New N,N-Bis-(3-aminopropyl) methylamine (BAPMA) Salt Formulation	Statement: Executive Summary: "...most highly exposed...children ages 1-2...42% of the cPAD." VII. Results/Discussion: "...chronic...children 1-2 years old had the highest chronic dietary risk at 42% of the cPAD." IX. Conclusions: "...chronic...Children 1-2...42% cPAD."	2 9 10	Comment: The text, while consistent with the select data presented in summary Table 5 (p 10) does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-	Memorandum. Dicamba and Dicamba	Statements in 4.3 – 4.5 (including subsections)	20 - 28	Comment: There appear to be inconsistencies both

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
2016-0223-0002	BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean			within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. See Appendix 1 to this document for specific comments.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available”</i>	4	Comment: These studies have already been submitted. Freshwater (Fathead Minnow): Acute: MRID 48718008 ELS: MRID 48718010 Saltwater (Sheepshead Minnow) ELS: MRID 48718011

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
	Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species”</i></p>	4	<p>Comment: This study has already been submitted. MRID: 48718013</p>
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)</i></p> <p><i>Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.</i></p> <p><i>Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies “</i></p>	4	<p>Comment: A chronic study with worker bees has been reported in the published literature which could be used to evaluate the potential chronic effects Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. A bee brood study with dicamba is available from the published literature that could be used to evaluate potential chronic effects of dicamba on newly emerged honey bees. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental</p>

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
				Entomology 1:611-614.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using dicamba’s metabolite, DCSA and the same species as used in the test with TGAI dicamba.”</i>	5	Question: Is the fish ELS study for DCSA required only for a freshwater species?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).”</i>	5	Comment: A residue decline study is available for dicamba on dicamba tolerant soybeans. The foliar dissipation of DCSA can be calculated from this study: “Determination of Dicamba Residue Decline in Forage after Application to Dicamba-Tolerant Soybean MON 87708 × MON 89788” MSL0022493. Also, there is foliar dissipation information for dicamba and DCSA in the magnitude of the residue study for dicamba tolerant soybeans: “Magnitude of Residues of Dicamba in Soybean Raw Agricultural and Processed Commodities after Application to MON 87708. MRID 48219901
EPA-HQ-OPP-2016-	Problem Formulation for the Environmental	Data Needs: <i>“Any new formulations for which an Endangered Species Act effect determination must</i>	5	Comment: The request for a Terrestrial Plants Field Study (850.4300) is not discussed elsewhere

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0223-0004	Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<i>be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300)."</i>		in the Problem Formulation document. Please provide additional information regarding what type of study is being requested.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>"It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury."</i>	9-10	Comment: If EPA is referring to the literature references cited in Footnote 1 on Page 7 of "Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)", it is important to note that none of the studies identified by EPA quantified or assessed vapor drift in any way. All of the reviewed papers intentionally made direct applications of dicamba at low rates to simulate particle drift – not volatilization – in order to assess plant effects at known rates.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Statement: <i>"... no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this</i>	13	Correction: Chronic studies on fathead minnow, sheepshead minnow, Daphnia magna, and mysid shrimp have been submitted. See Comments above for Page 4.

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	Review of Dicamba	<i>uncertainty.”</i>		
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>“as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA.”</i>	14	Correction: Chronic studies on fathead minnow and <i>Daphnia magna</i> are available for dicamba. See Comments above for Page 4.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2: Freshwater fish; Chronic (Early Life-Stage); No Data	14	Addition: Fathead Minnow NOAEC = 9.7 mg a.e./L MRID 48718010
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 4: Freshwater invertebrates; Chronic; No Data	14	Addition: <i>Daphnia magna</i> NOAEC = 42 mg a.e./L MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 6 Estuarine/marine fish; Chronic (Early Life-Stage); No Data	14	Addition: Sheepshead Minnow NOAEC = 11 mg a.e./L MRID 48718011

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	Drinking Water Assessments in Support of the Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 1 of Page 15 Estuarine/marine invertebrates; Acute; Grass shrimp EC ₅₀ >100 mg a.e./L	15	Question: EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) has the following endpoint: Grass shrimp EC ₅₀ > 132 mg a.e./L Which is correct?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2 of Page 15: Estuarine/marine invertebrates; Chronic; No Data	15	Addition: Mysid shrimp NOAEC = 11 mg/L MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 7, Row 1: Dicamba dimethylamine salt Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 > 112.4 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 > 977 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-	Problem	Table Endpoint:	15	Question:

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HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 8, Row 1: Dicamba sodium salt Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 = 111.6 mg a.e./L		The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 507.2 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 8, Row 2: Dicamba sodium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 9.2 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr EC50 34.6 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 10, Row 1: Dicamba potassium salt Bluegill Sunfish <i>Lepomis macrochirus</i> 96-Hr LC50 = 73.2 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 196 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Table Endpoint: Table 10, Row 2: Dicamba potassium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 301 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr

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	Assessments in Support of the Registration Review of Dicamba			EC50 639.8 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 1, Line 5: No acute oral data is available for dicamba's toxicity to passerine birds	17	Comment: A study for a passerine species has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 2, Line 4: Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees.	17	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993). Published literature studies report testing dicamba in a bee brood study and a chronic study with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614.

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EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 1: Birds, Acute Oral	18	Comment: Please clarify which study and endpoint the MRID number 42918001 refers to.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 2 Birds, Acute Oral (passerine) No data		Comment: An acute oral study for a passerine species is available with an endpoint LC50 > 213 mg a.e./kg bw. MRID 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 3 Subacute dietary: TGAI/TEP – 86.8%	18	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) indicates that the TGAI/TAP % ai is 86.6%
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Study Classification: Table 12, Row 3 of Page 19 Terrestrial Invertebrate Acute Contact (adult): The study is classified Supplemental / Quantitative.	19	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) lists MRID 00036935 as Acceptable. Please provide an explanation

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	Assessments in Support of the Registration Review of Dicamba			for any change in classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 4 Terrestrial Invertebrate Acute Oral (adult)	19	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 1 Birds, Acute Oral: Mallard Duck <i>Anus Platyrrhynchos</i> 14-D LC50>282 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >2452 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 2 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrrhynchos</i> 8-D LC50>2185 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4533 mg a.e./kg.
EPA-HQ-OPP-	Problem Formulation for the	Endpoint: Table 14, Row 1 Birds, Sub-acute dietary:	20	Comment: Has there inadvertently been a double correction

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2016-0223-0004	Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Bobwhite quail <i>Colinus virginianus</i> and 8-D LC50>2409 mg a.e./kg-bw		for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >9090 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 15, Row 1 of Page 21 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i> 8-D LC50>609 mg a.e./kg-bw	21	Correction: There has inadvertently been a double correction for acid equivalent content of the test substance. The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >1522 mg a.e./kg. This is consistent with an a.e. correction in the Science Chapter since the test substance was tested at 5620 ppm.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 16, Row 1 on Page 21 Birds, Acute Oral: Bobwhite quail <i>Colinus virginianus</i> 14-D LC50 = 235 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as 618 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Endpoint: Table 16, Row 1 on Page 22 Birds, Subacute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i>	22	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter

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	Assessments in Support of the Registration Review of Dicamba	8-D LC50>1822 mg a.e./kg-bw		for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4794 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 17, Row 2 Chronic (2-Generation Reproduction: Laboratory rat <i>Rattus norvegicus</i> NOAEL = 8 mg a.e./kg-diet/day LOAEL = 78 mg a.e./kg diet/day Endpoints: decreased pup weights	22	Comment: EPA's detailed analysis is not available to Monsanto; however, in general BMDL ₅ is a better, more refined estimate to use as a basis (point of departure) for the chronic risk assessment. In this case, 34.9 mg a.e./kg/day is the most appropriate value to use for the chronic risk assessment.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Study Classification: Table 19, Row 6 Aerobic Aquatic Metabolism: MRID 43758509 is listed as Supplemental	28	Comment: The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) classified this study as Acceptable. Please provide an explanation for the change in study classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 19, Row 5 of Page 29 MRID 49067704 is indicated to be a Field Volatility Study		Correction: MRID 49067704 is a field dissipation study
EPA-	Problem	Study Classification:	30	Comment:

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HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 20, Row 14, Page 30 Freshwater fish; Acute: MRID 00258932 is classified as Supplemental / Quantitative		MRID 258932 is classified as Supplemental / Qualitative in the EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 16, Page 30: Fresh invertebrates life cycle: No data	30	Comment: A <i>Daphnia</i> lifecycle study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 1, Page 31: Saltwater invertebrates life cycle: No data	31	Comment: A mysid lifecycle study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the	Data Needed: Table 20, Row 2, Page 31: Freshwater fish early-life stage: No data	31	Comment: A fathead minnow early-life stage study has already been submitted. MRID 48718010

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	Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 4, Page 31: Saltwater fish early-life stage: No data	31	Comment: A sheepshead minnow early-life stage study has already been submitted. MRID 48718011
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 32: Avian oral toxicity: No data on a passerine species	32	Comment: A passerine acute oral toxicity study has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 33: Honey bee adult acute oral toxicity (Tier 1): No Data	33	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-	Problem Formulation for the Environmental Fate, Ecological	Data Needed: Table 21 Honey bee adult chronic and larval acute and chronic testing: No Data	33-35	Comment: Published literature studies report testing dicamba in a bee brood study and a chronic study

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0004	Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba			with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614. These data could be used to evaluate whether chronic exposure to dicamba has any effects on honey bees.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 21, Last Row, Page 36 Vegetative Vigor: MRID 47814102	36	Correction: The MRID number should be 47815102
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Table A1.	38	Comment: Many of the rates given in this table do not seem to reflect the use rate limitations required in the 2009 Registration Eligibility Decision. Single Application Maximum – 1 lb a.e./A. Annual Application

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	Review of Dicamba			Maximum – 2 lb a.e./A.

`Appendix 1 to Monsanto Comments on Dicamba Registration Review Documents

EPA's Human Health Risk Assessment (HHRA) demonstrates that there is a reasonable certainty of no harm to the general public, including infants and children, from the proposed new uses of dicamba on dicamba-tolerant soybean and cotton.¹ However, EPA's decision to establish a chronic reference dose (cRfD) for dicamba of 0.04 mg/kg/day based on a Point of Departure (POD) of 4 mg/kg/day determined from the 2-generation rat reproduction study with the DCSA metabolite is extremely conservative and appears to lead to inconsistencies both within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. This decision is also inconsistent with (i.e., more conservative than) the conclusions of the Joint FAO/WHO Meeting on Pesticide Residues (JMPR).

Section 5.1.4 of the HHRA states, "Based on available toxicity studies and structural similarities, HED considers the parent and all three metabolites [DCSA, DCGA and 5-OH dicamba] to be of comparable toxicity." This is similar to the JMPR (2010) conclusion that "DCSA and DCGA have toxicity similar to or lower than that of dicamba" while 5-OH dicamba "appears to be of lower toxicity than the parent." In contrast, Section 4.3 of the HHRA indicates that DCSA is approximately 12-fold more toxic to offspring than dicamba acid. The latter statement is apparently based on the most recent EPA conclusions regarding the multi-generation rat reproduction studies with both compounds that were conducted at different times in different laboratories. Although full details are not available, this conclusion appears to be based, at least in part, on different Agency approaches used in evaluating or re-evaluating pup weights. Slight decreases in pup weight or pup weight gain relative to concurrent control were apparently reported in only one generation of both studies at 500 ppm. For DCSA, F1 pup weights at 500 ppm were lower than the concurrent control but were similar to those observed in the F2 controls as well as the laboratory's historical control values and were thus not considered to be a treatment related adverse effect. Although JMPR agreed with this conclusion, EPA concluded that 500 ppm was a Lowest Observed Adverse Effect Level (LOAEL). This resulted in a No Observable Adverse Effect Level (NOAEL) of 50 ppm, the next lowest concentration tested. In contrast, for dicamba, EPA apparently recently concluded that the decreased pup weights reported in one generation at both 500 and 1500 ppm were not treatment related due to the values being comparable to historical control data. EPA thus raised the dicamba offspring NOAEL from 500 ppm to 1500 ppm. It is not clear why comparisons to historical control data were acceptable for dicamba but not for DCSA. However, the end result is that although both the DCSA and dicamba studies appear to have similar marginal responses at 500 ppm, EPA conclusions regarding offspring NOAELs for these molecules are now quite different, 50 ppm and 1500 ppm, respectively. This does not appear to be consistent with the EPA conclusion that the two molecules exhibit comparable toxicity.

The EPA decision to reduce the chronic reference dose (cRfD) for dicamba from 0.45 to 0.04 mg/kg/day and to use this value for dietary risk assessment also does not appear to be justified. DCSA is only a very minor metabolite in conventional crops. Accordingly, the primary source for DCSA in the diet from the proposed uses will be from use of dicamba on dicamba-tolerant soybean (cotton consumption is negligible). However, based on the EPA analysis, potential residues in soybean represent only a very small percentage of the total dietary intake of dicamba. As a result, the vast majority of dietary exposure will be to parent dicamba, not DCSA.

¹ M1768 and M1769 herbicides would also be covered under the current HHRA for dicamba.

Therefore, it would seem more appropriate to assess the risks from these residues utilizing a cRfD based on dicamba data rather than an 11-fold lower cRfD based on a marginal response seen in a DCSA study.

The cRfD of 0.04 mg/kg/day proposed by EPA for use in dietary risk assessment is much lower than the value recommended by JMPR. JMPR concluded that the NOAEL for both the dicamba and DCSA rat reproduction studies was 500 ppm (~35 mg/kg/day for dicamba and ~37 mg/kg/day for DCSA). JMPR then concluded that an Acceptable Daily Intake (ADI) of 0.3 mg/kg/day was appropriate to characterize potential risks to both dicamba and its metabolites. This value was based on the NOAELs from the rabbit teratology and rat reproduction studies with dicamba and a 100-fold uncertainty factor.

Finally, the use of a Point of Departure (POD) of 4 mg/kg/day from the DCSA rat reproduction study for determining the cRfD for dicamba seems inconsistent with information included in the Second Addendum to the Environmental Fate and Ecological Risk Assessment (March 24, 2016). According to that document, EPA has conducted a benchmark dose analysis of the DCSA reproduction study and concluded that the threshold value for the NOAEL would be 8 mg/kg/day and that the lower 95% confidence limit on the benchmark dose resulting in a 5% change from background (BMDL₅) would be 34.9 mg/kg/day. It is not clear why these analyses were not summarized and utilized in the selection of the POD and cRfD in the HHRA.

TOXIC CONCOCTIONS

HOW THE EPA IGNORES THE DANGERS OF PESTICIDE COCKTAILS.



BY NATHAN DONLEY, PH. D.

CENTER FOR BIOLOGICAL DIVERSITY

JULY 2016

Executive Summary

More than 1 billion pounds of pesticides are used in the United States each year, applied to agricultural fields and orchards, residential lawns, playgrounds and parks. Pesticides are often mixed with other pesticides and chemicals before application or after, and the individual ingredients in these mixtures can interact in such a way as to enhance their toxic effects. **This is referred to as “synergy,” and it can turn what would normally be considered a safe level of exposure to people, wildlife and the environment into one that causes considerable harm.**

Although pesticide mixtures in the environment have been extensively documented, the Environmental Protection Agency generally only assesses the toxicity of pesticides individually, in isolation from potential real-life scenarios where these pesticides may interact with other chemicals. The EPA, which is tasked with ensuring that pesticides do not result in unreasonable harm to human health and the environment, often rationalizes this approach by stating that studies measuring mixture toxicity are often not available for analysis.

Our analysis, however, contradicts that claim by utilizing a publicly available information source (data from the U.S. Patent and Trademark Office) that provides a disturbing snapshot of pesticide synergy and the potential for widespread danger to people, waterways and wildlife — risks the EPA has repeatedly failed to identify and consider during its approval process.

For this report we conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta).

Among our key findings:

- 69 percent of these products (96 out of 140) had at least one patent application that claimed or demonstrated synergy between the active ingredients in the product;
- 72 percent of the patent applications that claimed or demonstrated synergy involved some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, among others, indicating that potential impacts could be widespread.

This suggests that synergistic action between pesticide active ingredients is much better documented and more common than current EPA pesticide assessments would indicate. Further, it appears that pesticide companies are in fact collecting information about the synergistic effects of their products that they are not sharing with the EPA. Recognizing that pesticide synergy data are widely available and that the synergistic relationships between pesticides can have serious implications for human and environmental health, the EPA must now take action to properly consider the potential consequences of pesticide synergy.

Introduction

Pesticide Registration

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), before a pesticide can be sold or distributed in the United States it must be registered — that is, approved — by the EPA. By law the EPA can only register a pesticide if its use will not cause unreasonable adverse effects on the environment.¹ To analyze whether any possible adverse effects may occur, the agency requires that toxicity studies be submitted to it by the chemical companies that plan to sell the pesticide (subsequently referred to as “pesticide registrants”). These studies typically analyze the relative toxicities of the pesticide to different taxa of plants and animals.² Once these data are analyzed, the EPA conducts a cost-benefit analysis that weighs the environmental costs with the purported economic benefits of pesticide use and decides whether or not to register a given pesticide.

The data that are required to be submitted by pesticide registrants almost always involve the use of a single pesticide in the absence of any other added chemicals. In reality pesticide exposures never occur in isolation. Pesticides are typically sold as formulations, meaning the pesticide is mixed with other chemicals in the bottle. These other chemicals can be other pesticides or “inert” ingredients, which are chemical additives that can affect the toxicity or absorption of the pesticide.³ In addition, pesticide products are often mixed in the field before application with other ingredients called “adjuvants”⁴ and/or other pesticide products. Pesticides that are applied on different geographic areas can also migrate away from the site of application and mix together in the environment.⁵ The EPA toxicity data requirements from chemical companies that focus on a single ingredient, combined with the fact that government and academic researchers often don’t have the means to study the vast landscape of mixture toxicity in sufficient detail, leads to an enormous gap in our knowledge of pesticide mixture toxicity.

Chemical Interactions

When chemicals mix in the environment, one of two things can happen: 1) the chemicals can interact in such a way as to change their toxicity profiles or 2) no interaction occurs. When chemicals do not interact, this is generally referred to as “additivity,” which means that no chemical in the mixture influences the toxicity of the other chemical(s) and toxicity can be estimated by how the chemicals act on their own. Alternatively, chemicals can interact to increase or decrease toxicity beyond the sum of the individual effects, which is referred to as “synergism” or “antagonism,” respectively.⁶ Synergism is particularly worrisome from a regulatory point of view, because, if it is not properly taken into account, adverse effects on human health or the environment can be much greater than originally estimated.

The EPA’s current guidance on how to assess mixture toxicity to humans directs the agency to assume that no interaction is occurring as a default unless available data indicate otherwise.⁷ In practice, because of the enormous data gaps on mixture toxicity, the EPA almost exclusively ends up assuming “no interaction” when the agency analyzes mixture toxicity to humans. There is currently no guidance on how the EPA assesses mixture toxicity to plants and animals other than humans, and the ecological risk assessment process does not generally assess pesticide mixture toxicity.⁶

Patent Applications

The extensive gaps in our knowledge of mixture toxicity ultimately weaken the EPA’s ability to effectively regulate pesticides, and new sources of data need to be identified. One new source of data was recently brought to the forefront with EPA’s approval of Enlist Duo, a new pesticide product from Dow that combines glyphosate and 2,4-D into one formulation for use on second generation genetically engineered crops. Following its registration of Enlist Duo, in preparing to defend itself in subsequent litigation on the registration

decision, the EPA came across a patent application from Dow that indicated glyphosate and 2,4-D result in synergistic toxicity to plants. This meant that the EPA's evaluation of the product at the registration phase lacked a full consideration of impacts to nontarget plants, including endangered species. The discovery of this patent application spurred the EPA to further request any relevant data from Dow about possible synergies and ultimately ask a court to vacate its decision to register Enlist Duo.⁸

When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office (USPTO) has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant.⁹ For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

In the case of Enlist Duo, the fact that publicly available data from a patent application was unknown to the EPA until it was working to defend itself in litigation highlights just how broken this process is. Enormous data gaps, coupled with nonconservative measures of mixture toxicity, have created a precarious framework of assumptions that, in many cases, underestimates the toxicity of pesticide mixtures to humans and the environment.

Analysis

Pesticide Products

For this analysis we sought to understand just how extensive the patent landscape was regarding claims of pesticide synergy. To ensure that our analysis was relevant to pesticide mixtures that were going to be encountered in the environment, we limited it to products that

contain multiple pesticide ingredients (subsequently referred to as "active ingredients"). Specifically, we identified all of the products from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta — hereafter referred to as "The Big Four") the EPA approved in the past six years that contained two or more active ingredients.¹⁰ This way we identified pesticides that were absolutely certain to be co-applied because they are sold together in a single product. A more detailed description of our methodology is outlined in Appendix A.

We found 140 products from The Big Four, approved between June 2010 and June 2016, that contained at least two active ingredients. Each product contained anywhere from two to six active ingredients, and all were characterized as an herbicide, insecticide or fungicide/nematicide. The largest group of multi-ingredient products from The Big Four that have been approved in the past six years was herbicides, accounting for 67 of the 140 products. A breakdown of the products by company indicates that Bayer, Dow, Monsanto and Syngenta had 49, 26, 5 and 60 products that were included in our analysis, respectively.

Synergy Patents

We then searched various databases for patent applications that made a claim of synergy for at least two of the active ingredients in the product (methodology outlined in Appendix A). Only patent applications submitted to the USPTO were included in this analysis; patent applications in other countries were excluded. All patent applications that were granted, denied or still in the application process were included in our analysis because the status of the application has no bearing on the underlying accuracy of the synergy claims. The USPTO generally does not pass judgment on whether synergy exists or not; it takes applicants at their word, only considering whether the claims are nonobvious and therefore patentable.

Remarkably, of the 140 pesticide products included in our analysis that contain multiple active ingredients, 96 had at least one patent

application that claimed or demonstrated synergy between the active ingredients in the product, a total of 69 percent (Figure 1a and Appendix B). These 96 products had at least one patent application and as many as six, claiming or demonstrating synergy between the active ingredients in the product. The majority of patent applications contained experimental data that were included in the application as evidence of the claimed synergy. For all patent applications, synergy was claimed or demonstrated for target organisms (i.e. synergistic toxicity to target insect species for insecticidal ingredients). A breakdown of the patent synergy claims by company indicates that 71 percent (35/49), 46 percent (12/26), 40 percent (2/5) and 78 percent (47/60) of Bayer, Dow, Monsanto and Syngenta products had patent applications that claimed synergy between at least two of the active ingredients in the product, respectively.

As some of the approved products contained similar ingredients, many patent applications covered multiple products. There were a total of 47 patent applications that covered the ingredient mixtures in the products included in our analysis.¹¹ Many of the ingredients covered by

these patent applications are very widely used, with 72 percent (34/47) of patent applications involving high use ingredients (more than 1 million pounds used per year in the U.S. agricultural sector) (Figure 1b).¹²

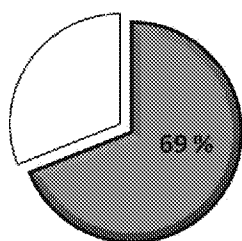
Acuron, a case study

In 2015 the EPA conditionally registered a pesticide product from Syngenta called Acuron (EPA Reg. No. 100-1466, Decision No. 470872). Acuron combines four different active ingredients — bicyclopyrone, S-metolachlor, mesotrione and atrazine — into a single formulation to control weeds in cornfields. The approval of the Acuron product was combined with the approval of the new active ingredient bicyclopyrone, and therefore went through public review and comment.¹³

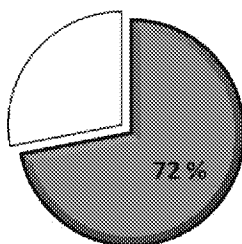
In response to the Center for Biological Diversity's public comments regarding possible synergistic effects of Acuron, the EPA stated: "Concerning synergistic effects, the agency does not routinely include a separate evaluation of mixtures of active ingredients. However, there are some data available to the agency regarding synergistic effects and EPA believes it adequately addressed the issue of synergism between bicyclopyrone and atrazine."¹⁴ But the EPA provides no information on how it addressed this issue of synergism as there is no mention of this analysis in the ecological risk assessment,¹⁵ no separate analysis was provided to the public, and there was no mention of whether synergy was analyzed for ingredient combinations other than bicyclopyrone and atrazine. The agency further indicated that a study of acute toxicity of Acuron to mammals was analyzed and did not indicate synergy was occurring.¹⁴ However, it did not analyze chronic toxicity to mammals or acute and chronic toxicity to all other taxa like birds, fish, invertebrates and plants as a result of Acuron exposure prior to approving this product.

As Acuron is a Syngenta product that was approved in the past six years, it was included in our patent analysis. We found three patent applications claiming synergistic toxicity to plants

Fig 1 A) Percentage of Recently Approved Multi-ingredient Products That Have Evidence of Synergy



B) Percentage of Identified Synergy Patents That Involve High Use Ingredients



from exposure to the ingredients in this product: the combination of 1) S-metolachlor and mesotrione (app # 12374219), 2) mesotrione and atrazine (app # 12675156) and 3) atrazine and S-metolachlor (app # 08930901) (Appendix B). Since bicyclopyrone has the same mode of action as mesotrione,¹⁶ it is likely that any synergy observed with mesotrione and other ingredients will be present with bicyclopyrone and those ingredients as well. Synergistic toxicity of mesotrione and atrazine to certain species of plants has also been extensively documented in the literature.^{17- 22} Finally, in publicly available promotional materials for Acuron, Syngenta has not only claimed that mesotrione and bicyclopyrone work synergistically with atrazine to kill plants, but they have mapped out the exact mechanism by which synergy occurs.²³

It is clear that there are at least three and as many as five layers of synergy that result from the combination of ingredients in Acuron (Figure 2). This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them. The EPA is charged with ensuring that pesticide use results in no unreasonable adverse effects to the environment or harm to endangered or threatened species. It is still unclear how the agency came to its conclusion for Acuron without properly considering this publicly available, relevant information.²⁴

Discussion

Our analysis indicates that there are patent applications claiming or demonstrating synergistic action for 69 percent of the recently approved products from The Big Four pesticide companies that contain multiple active ingredients. This percentage is very high and disconcerting. Synergy between chemicals is not generally thought to be a very common phenomenon, which is one reason regulatory agencies typically assume additivity. However, in the case of premixed products, this high percentage makes perfect sense. Combining synergistically acting chemicals into a single product not only allows a company to gain patent protection on the combination of ingredients in their product, but, from a product performance point of view, it makes sense to combine ingredients that will enhance each other's ability. Unfortunately enhancing toxicity to target organisms will often enhance toxicity to many nontarget organisms as well. Perhaps most worrisome is that 72 percent of the patent applications we identified claimed or demonstrated synergy with some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, indicating that potential impacts could be widespread.

We're also certain that 69 percent is an *underestimate* of how many of these products have synergistic activity. There are multiple reasons for this conclusion:

1. We only took into account U.S. patent applications. In our search we found multiple relevant patent applications filed with other countries as well as with the World Intellectual Property Organization (WIPO). For example, a U.S. patent application could not be identified for the product combining methoxyfenozide and spinetoram (EPA reg No. 62719-666), however Dow submitted a patent application

Fig 2

Synergy Evidence for Acuron (mesotrione, S-metolachlor, bicyclopyrone, atrazine)

Line of evidence	patent claim	published studies	promotional materials	based on mode of action
S-metolachlor + mesotrione	X			
mesotrione + atrazine	X	X	X	
S-metolachlor + atrazine	X			
bicyclopyrone + atrazine			X	X
bicyclopyrone + S-metolachlor				X

to the WIPO claiming that this active ingredient combination works synergistically to kill an insect target organism.²⁵

2. Many relevant patent applications may not be publicly available yet. The products that we analyzed were approved relatively recently, and it is therefore likely that some relevant patent applications were filed recently as well. The USPTO delays the publishing of patent applications for 18 months after the date of first filing.²⁶ So any patent applications filed within the past year and a half may not be publicly available and would not have been identified by our search strategy.
3. Because “inert” ingredients in pesticide products are not made available to the public, we were unable to search for patent applications that demonstrated synergy between the active ingredients and other ingredients contained in the pesticide product. We did come across many patent applications claiming synergy between the active ingredients in the analyzed products and commonly used “inert” ingredients;²⁷ however, the lack of ingredient transparency in pesticide products prohibited the inclusion of possibly relevant patent applications. Therefore, more layers of synergy may be present in these products than were identified in this analysis.
4. Searching for patent applications is surprisingly difficult. It is possible that our search strategy (Appendix A) missed relevant patent applications.
5. We only searched for claims of synergy in patent applications. As was the case with Acuron, some of these chemical combinations may have been demonstrated to act synergistically on target or nontarget organisms in peer-reviewed scientific studies. Any such study would not have been identified in our analysis. Furthermore, any unpublished, internal studies done by chemical companies would, of course, not be identified either.

Pesticide companies likely possess additional information regarding pesticide synergy that they do not include in their patent applications. Patent applications are very different from scientific studies, which are the typical data source used by the EPA to assess risk. The latter are very descriptive and data intensive, while the former provide the bare minimum of information required to demonstrate to the patent office that their claim is legitimate. This does not necessarily mean that experimental data provided in patent applications are somehow less scientifically valid than data from scientific studies, only that more data may be available from the patent applicant than was provided to the patent office. The EPA acknowledged this fact in the Enlist Duo case by not just relying on the information contained in the relevant patent application, but also requiring Dow to submit any relevant data on the synergy between glyphosate and 2,4-D that was in its possession.⁸ In many cases the patent applicant will have additional data on synergism in their possession, as extensive experimentation is typically done before a company will invest the time and money to develop a product that they intend to market. It is important that this be kept in mind when scientifically evaluating the data contained in patent applications.

We cannot say with absolute certainty that the patent data on synergy that we identified were not used in making registration decisions for these products. There are multiple reasons for this. The first is that, unlike Acuron, many individual products are given approval without public review and comment, so the analysis that went into the product approval, if any, is not shared with the public. Second, even when products do go through public review and comment, a mixture toxicity analysis is either not performed or not outlined in sufficient detail for the public to understand all of the lines of evidence that were used. However, given that, in the case of Enlist Duo, the EPA indicated that it just recently became aware that patent data on synergy exist and the fact that it is not common practice to do a mixture analysis for the ecological risk assessment, we think it is extremely likely

that most, if not all, of these product approvals were made without taking into account this relevant patent information.

It is also unclear why the EPA has not previously been made aware of these patent data by pesticide registrants. Registrants are required to submit information to the EPA that could raise concerns about the continued registration of a product or about the appropriate terms and conditions of registration.²⁸ For example, pursuant to 40 CFR §159.195(a)(3), the registrant is required to submit information that indicates “[u]se of a pesticide may pose any greater risk than previously believed or reported to the Agency.” Data on chemical synergy would certainly fall into that category. It appears that chemical companies are using synergy to demonstrate that chemical combinations have some sort of novelty associated with them and are, therefore, patentable — yet when it comes to the toxicities associated with this synergy, this information never makes it to the EPA.

Recommendations

Searching for patent applications can be a difficult process that takes considerable time and knowledge. Often the pesticide is not referred to by its common name in the patent application, making a simple keyword search insufficient to identify all relevant patent information. The EPA cannot rely on stakeholders to provide all of the necessary information from patent applications, but rather the EPA must place the burden to produce and submit information related to synergistic effects squarely where it belongs: on the pesticide registrant or applicant.

1. Registrants or applicants need to be made aware that failure to submit relevant data to the EPA will be a violation of their duties under Section 6(a)(2) of FIFRA.²⁹ When applicable, enforcement should be pursued when registrants fail to provide those data.
2. To identify patent data that are not affiliated with the pesticide registrant, the EPA needs to use a stepwise approach of

doing a keyword and structure search for patent applications concerning the pesticide of interest followed by a rigorous analysis of the claims in the patent application.

3. Any claims of synergy need to be assessed for relevance given the label restrictions for the pesticide (or lack thereof) and the inert ingredients that are present in any formulation up for approval.
4. Appropriate measures need to be taken to ensure that any registration decision is compliant with FIFRA. This may include label restrictions on mixing, increased in-field buffers, lower application rates or even product cancellation.

A full analysis of mixture toxicity needs to be taken into account for both the human health and ecological risk assessments. When patent applications or other data demonstrate synergistic toxicity to target organisms, that synergy needs to be assumed for all other nontarget organisms within that taxon. For instance if a mixture results in synergistic toxicity to a target insect, like an aphid, then that synergy needs to be assumed for all insects and possibly all other invertebrates in the ecological risk assessment unless available data indicate otherwise. This would be consistent with EPA’s current use of surrogate species to estimate toxicity to other species within the same taxon for the human health and ecological risk assessments. This is one way that the EPA can begin to take into account mixture toxicity given the extensive data gaps that are currently present.

Conclusions

The human health and ecological risk assessments are a key part of the EPA’s pesticide-approval process; without them the agency cannot justifiably conclude that a pesticide can be used without unreasonable harm. When relevant data are not included in the risk assessment, and nonconservative assumptions are made about mixture toxicity, it diminishes the process and ultimately underestimates harm to humans and the environment.

The patent applications identified in this analysis are just the tip of the iceberg. The patent landscape on pesticide mixtures is vast and in no way limited to pesticides that are sold together in formulations. In fact, the implications of this analysis should extend far beyond that of multi-ingredient product approval. The entire pesticide-approval process is designed to narrowly assess the toxicity of individual active ingredients one at a time; yet when most of these active ingredients are being routinely co-applied on agricultural fields across the country, the initial analyses that were done are no longer relevant to real-world

exposure scenarios and are not an appropriate estimate of true risk.

This analysis highlights the shortcomings of such a narrow approach. Since mixture toxicity is such a low priority for the EPA, it is no surprise that relevant information was missed for so long. Clearly pesticide synergy is not a rare occurrence and should no longer be treated as such. The EPA must take into account relevant patent data and other lines of evidence and fundamentally alter its approach to assessing pesticide mixtures.

Appendix A

Methodology of Product Search

We used the EPA's Pesticide Product Label System database to conduct our search.³⁰ In the "company name" search box we searched for "Bayer," "Dow Agrosiences LLC," "Monsanto Company" and "Syngenta Crop Protection," which identified 685, 369, 176 and 539 products respectively. These are all of the pesticide products with "active" status for these four companies as of June 23, 2016 (a total of 1769). To identify the products that had their initial approval in the last six years *and* had multiple active ingredients, we found all active products that had a date on or after June 23, 2010 in the "current status" column. We then searched the pesticide labels of each of those products. If the label indicated two or more active ingredients were present in the product, it was included in our analysis. Of the 1769 active products for these companies, 140 had multiple active ingredients and were first approved by the EPA in the past six years. All of these products are listed in Appendix B.

Methodology of Patent Search

To identify all applicable patent applications, we used a multi-layered search strategy. First, we used the search engines from Google Patents,³¹ FreePatentsOnline³² and the USPTO³³ to do simple keyword searches. The common names of each pesticide were searched concomitantly with the words "synergy," "synergistic" or "synergism." We found many relevant patents using this strategy, but quickly became aware of the limitations of doing a simple keyword search. Many patent applicants do not refer to pesticides by their common name but instead use a common core structure along with various possible side groups to describe the chemicals they want to patent. In order to identify these patents, we used a search engine called SureChEMBL.³⁴ This allows the user to search patent applications for the chemical structure of the pesticide in conjunction with keywords. In addition, we used SciFinder³⁵ to search patent applications by the pesticide's Chemical Abstracts Service (CAS) number and filtered results by other pesticides mentioned in the patent or by the word "synergistic."

All of the patents we identified were further scrutinized. First, any patent application that was not

submitted to the USPTO was discarded. This is because many of the patent applications submitted to other countries that we identified were in a language other than English; however, we note that this discarded information could likely be useful to the EPA. We then went through each of the identified patents and verified that claims of synergy were made for at least two of the active ingredients in the product. If it was stated anywhere in the patent application that a mixture of chemicals acted synergistically to produce toxicities to any organism, that patent was used in our analysis. However, we note that a strong majority of patent applications also contained experimental evidence of synergy.

Notes were taken on each patent included in our analysis, including:

- 1) The company that was listed as the applicant or assignee of the patent application and whether this was different from the registrant of the product.
- 2) The taxa of the organism(s) for which synergy was claimed (plants, insects, fungi, nematodes).
- 3) If there was a possible difference in stereoisomer content of the chemicals in the pesticide product and the patent application. Since lambda-cyhalothrin is a mixture of enantiomers, one of which is gamma-cyhalothrin, any claims of synergy for one was assumed for the other. Similarly, since mefenoxam is one of the two enantiomers that are present in metalaxyl, any claims of synergy for one was assumed for the other.
- 4) If any experimental evidence of synergy was provided in the patent application as well as the magnitude of the synergy as measured by the Colby equation.³⁶ If experimental data were provided in the application and a Colby analysis was performed, the extent of synergy (low, medium and high) was noted for each patent application. The observed response (C_{obs}) and the expected response (assuming no interaction) (C_{exp}) were used to make this determination. If the difference of C_{obs} and C_{exp} was less than 10, that was considered low synergy. If the difference of C_{obs} and C_{exp} was between 10 and 20, that was considered medium synergy. And if the difference of C_{obs} and C_{exp} was greater than 20 or if C_{obs}/C_{exp} was greater than 2, then that was considered high synergy. Also, if experiments were performed but no data were provided, or if experimental data were given but no Colby equation was done, we took note of that as well (Appendix B).

Appendix B

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
7/14/2010	D	62719-616	penoxsulam; cyhalofop												
7/20/2010	S	100-1369	thiamethoxam; fludioxonil; azoxystrobin; mefenoxam	10496187	3	F	S	10170902	1, 7	F	S				
7/25/2010	B	72155-90	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
7/26/2010	B	72155-91	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
7/26/2010	B	72155-89	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
8/2/2010	B	264-1103	lodosulfuron-methyl-sodium; mesosulfuron-methyl												
8/3/2010	D	62719-617	aminopyralid; metsulfuron methyl	12945099	6	P	D								
8/5/2010	S	100-1366	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/5/2010	S	100-1367	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/6/2010	D	62719-612	penoxsulam; isoxaben												
9/3/2010	S	100-1352	fludioxonil; mefenoxam; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S				
10/14/2010	B	432-1513	trifloxystrobin; triadimefon												
10/29/2010	S	100-1384	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
11/24/2010	S	100-1385	fomesafen; glyphosate												
1/20/2011	B	352-846	aminocyclopyrachlor; chlorsulfuron												
1/20/2011	B	352-848	aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
1/20/2011	B	352-847	imazapyr; aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
2/16/2011	S	100-1389	pinoxaden; fluroxypyr												
3/2/2011	S	100-1396	fomesafen; glyphosate												
3/10/2011	D	62719-630	2,4-D; aminopyralid	13014909	6	P	D								
3/10/2011	D	62719-628	2,4-D; aminopyralid	13014909	6	P	D								
3/11/2011	S	100-1377	azoxystrobin; propiconazole												
3/11/2011	S	100-1378	azoxystrobin; propiconazole												
3/24/2011	S	100-1393	fludioxonil; mefenoxam	8799310	1, 3	F	S								
4/10/2011	D	62719-629	2,4-D; aminopyralid	13014909	6	P	D								
4/12/2011	S	100-1364	chlorothalonil; acibenzolar-S-methyl												
4/12/2011	B	72155-98	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-99	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-100	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-101	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/26/2011	B	72155-104	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
4/29/2011	B	264-1132	clothianidin; Bacillus-firmus I-1582	12936700	3	I, F, N	B								
5/2/2011	B	72155-102	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/2/2011	B	72155-103	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/5/2011	D	62719-637	triclopyr; fluroxypyr												
6/3/2011	S	100-1402	<i>lambda</i> -cyhalothrin; chlorantraniliprole												
6/13/2011	B	72155-105	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
6/15/2011	S	100-1399	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
				14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
6/27/2011	D	62719-640	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
8/12/2011	B	72155-106	2,4-D; isoxaben; mecoprop-p; dicamba	13841457	6	P	B								
8/17/2011	B	264-1134	lodosulfuron-methyl sodium; thien carbazon-methyl	12824951	6	P	B								

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/19/2011	S	100-1405	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
				14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
11/16/2011	S	100-1410	S-metolachlor; mesotrione	12374219	6	P	S								
12/6/2011	B	264-1135	thiencarbazone-methyl; pyrasulfotole; bromoxynil	12824951	4	P	B								
12/14/2011	S	100-1414	S-metolachlor; mesotrione; atrazine	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
1/11/2012	S	100-1415	azoxystrobin; thiamethoxam												
1/26/2012	B	432-1519	thiencarbazone-methyl; foramsulfuron; halosulfuron-methyl	13902364	5	P	B	12824951	5	P	B				
2/1/2012	S	100-1433	azoxystrobin; difenoconazole	10496185	8	F	S								
2/2/2012	S	100-1427	thiamethoxam; mefenoxam; fludioxonil	13209926	2, 3	F	Bf	8799310	1, 3	F	S				
2/2/2012	S	100-1426	thiamethoxam; mefenoxam; fludioxonil; thiabendazole	11563240	6	F, N	S	8799310	1, 3	F	S				
2/2/2012	B	264-1091	fluopyram; tebuconazole												
2/2/2012	B	264-1090	fluopyram; trifloxystrobin												
2/2/2012	B	264-1085	fluopyram; pyrimethanil												
2/2/2012	B	264-1084	fluopyram; prothioconazole												
2/7/2012	D	62719-646	acetochlor; atrazine												
2/14/2012	S	100-1429	pinoxaden; fenoxaprop-p-ethyl												
2/15/2012	D	62719-645	clpyralid; aminopyralid	13715230	6	P	D	14102818	6	P	D				
2/22/2012	S	100-1428	difenoconazole; mefenoxam												
4/23/2012	S	100-1436	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/23/2012	S	100-1437	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/27/2012	B	72155-107	metsulfuron-methyl; thiencarbazone-methyl; indaziflam; dicamba	12824951	6	P	B	12506456	3	P	B				
4/30/2012	S	100-1438	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
5/11/2012	B	264-1125	penflufen; clothianidin	11912773	6	I	B								
5/11/2012	B	264-1123	penflufen; prothioconazole	13061976	3	F	B								
5/11/2012	B	264-1122	prothioconazole; penflufen; metalaxyl	10508208	2, 3	F	Bf	12663273	5	F	B				
5/11/2012	B	264-1124	penflufen; trifloxystrobin	12663273	4	F	B								
5/11/2012	B	164-1121	clothianidin; penflufen; trifloxystrobin; metalaxyl	11793763	6	I	B	10486663	6	I	B	12663273	5	F	B
				13209926	2, 3	F	Bf	11912773	6	I	B				
6/20/2012	S	100-1383	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
6/21/2012	S	100-1440	abamectin; thiamethoxam	11028776	7	I	S								
8/2/2012	S	100-1442	S-metolachlor; mesotrione; atrazine	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
8/23/2012	S	100-1449	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
10/31/2012	S	100-1441	chlorothalonil; difenoconazole	12066894	8	F	S								
12/6/2012	S	100-1455	mesotrione; proflumicarb	12374195	6	P	S								
1/15/2013	M	71995-57	glyphosate; diquat dibromide												
1/15/2013	M	71995-56	glyphosate; diquat dibromide												
1/15/2013	S	100-1457	abamectin; thiamethoxam; mefenoxam; fludioxonil	11028776	7	I	S	8799310	1, 3	F	S				
1/22/2013	B	432-1528	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
1/23/2013	S	100-1458	<i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
1/30/2013	S	100-1459	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
1/30/2013	S	100-1460	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
3/5/2013	D	62719-655	2,4-D; picloram												
3/7/2013	D	62719-653	2,4-D; picloram												
4/2/2013	D	62719-673	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
4/3/2013	D	62719-671	atrazine; acetochlor												
4/4/2013	D	62719-668	atrazine; acetochlor												
4/4/2013	D	62719-670	atrazine; acetochlor												
6/11/2013	B	432-1527	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
6/12/2013	S	100-1444	thiamethoxam; fludioxonil; difenoconazole	7792845	4	F	S								
6/17/2013	S	100-1470	glyphosate; mesotrione												
6/19/2013	B	72155-110	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
7/22/2013	D	62719-666	methoxyfenozide; spinetoram												
8/8/2013	B	352-845	aminocyclopyrachlor; sulfometuron-methyl; chloresulfuron												
8/29/2013	D	62719-667	methoxyfenozide; spinosad												
2/3/2014	D	62719-648	cyhalofop; fluroxypyr	12913235	6	P	D								
2/6/2014	S	100-1421	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1422	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1424	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/27/2014	D	62719-679	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	M	524-614	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	S	100-1508	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
4/22/2014	M	524-616	dicamba; glyphosate	13099552	2, 6	P	D	13751021	7	P	M				
5/16/2014	D	62719-680	sulfentrazone; cloransulam-methyl												
5/29/2014	S	100-1527	thiamethoxam; difenoconazole; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				7792845	4	F	S	12278731	6	F	S				
5/30/2014	S	100-1526	difenoconazole; mefenoxam; fludioxonil; sedaxane	8799310	1, 3	F	S	7792845	4	F	S	12278731	6	F	S
6/10/2014	B	264-1168	fenoxaprop-p-ethyl; pyrasulfotole; bromoxynil octanoate; bromoxynil heptanoate												
7/16/2014	S	100-1540	propiconazole; azoxystrobin												
7/29/2014	B	432-1533	foramsulfuron; iodosulfuron-methyl; thiencazone-methyl	13902364	5	P	B	12824951	6	P	B				
9/29/2014	B	264-1170	spirotriamat; imidacloprid	13790375	7	I	B								
10/10/2014	S	100-1555	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
10/15/2014	D	62719-649	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
11/12/2014	B	432-1530	imidacloprid; spirotriamat	13790375	7	I	B								
12/2/2014	S	100-1530	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
12/22/2014	S	100-1549	azoxystrobin; propiconazole; <i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
12/23/2014	S	100-1550	azoxystrobin; acibenzolar-S-methyl												
1/12/2015	S	100-1506	azoxystrobin; difenoconazole	10496185	8	F	S								
1/14/2015	S	100-1554	azoxystrobin; difenoconazole	10496185	8	F	S								
2/6/2015	B	264-1171	imidacloprid; fluopyram												
4/13/2015	M	524-620	acetochlor; fomesafen												
4/21/2015	B	72155-112	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/21/2015	B	72155-113	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/24/2015	S	100-146	atrazine; bicyclopyrone; S-metolachlor; mesotrione	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
4/27/2015	D	62719-689	cloransulam-methyl; flumioxazin												
7/17/2015	B	72155-114	tau-fluvalinate; tebuconazole												
8/5/2015	S	100-1561	sedaxane; mefenoxam; fludioxonil	8799310	1, 3	F	S	12278731	6	F	S				
8/23/2015	S	100-1450	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
8/28/2015	D	62719-685	clopyralid; fluroxypyr; pyroxusulam												

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/8/2015	B	432-1544	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
10/19/2015	S	100-1556	thiamethoxam; fludioxonil; difenoconazole; sedaxane	12306870	2, 6	I	B	7792845	4	F	S	12278731	6	F	S
10/19/2015	S	100-1559	thiamethoxam; mefenoxam; thiabendazole; fludioxonil; sedaxane	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
11/10/2015	B	11556-186	diflubenzuron; permethrin												
12/9/2015	B	264-1182	penflufen; trifloxystrobin; metalaxyl	12663273	5	F	B								
1/6/2016	D	62719-693	acetochlor; mesotrione; clopyralid	12074809	3	P	D								
2/3/2016	S	100-1564	thiamethoxam; difenoconazole; mefenoxam; sedaxane; cytokinin; gibberellic acid; indole butyric acid	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
2/8/2016	S	100-1568	bicyclopyrone; mesotrione; S-metolachlor	12374219	6	P	S								
2/17/2016	B	264-1184	dicamba; tembotrione												
2/24/2016	D	62719-702	penoxsulam; oxyfluorfen	13014869	6	P	D								
4/11/2016	B	432-1583	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
4/12/2016	S	100-1563	thiamethoxam; thiabendazole; sedaxane; mefenoxam; fludioxonil	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
6/16/2016	S	100-1587	fludioxonil; sedaxane; thiamethoxam	12278731	3	F	S	12306870	2, 5	I	B				
6/20/2016	B	432-1537	fluopyram; trifloxystrobin												

Column 1: Date that the product was first approved by the EPA

Column 2: Registrant of the approved product (D=Dow, M=Monsanto, S=Syngenta, B=Bayer)

Column 3: Registration number of the product. Information on products can be found by searching the registration number on the EPA's Pesticide Product Label System found here:

<https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>

Column 4: A list of the active ingredients found in each product

Column 5: The patent application number. Patent applications can be searched by application number on USPTO's Public Pair Portal found here:

<http://portal.uspto.gov/pair/PublicPair>

Column 6: Notes taken on the patent. **For more detailed information see Appendix A**

1 = Stereoisomer content of a pesticide in the product may differ from that analyzed in the patent.

2 = Applicant/assignee of patent application differs from the registrant of the product

3 = No experimental evidence was provided in the patent application

4 = Experimental evidence was provided in the patent application, which indicated low synergy

5 = Experimental evidence was provided in the patent application, which indicated medium synergy

6 = Experimental evidence was provided in the patent application, which indicated high synergy

7 = Experimental evidence was provided in the patent application but no Colby equation was performed

8 = Experiments were said to be performed but data were not provided in the patent application

Column 7: Taxa for which synergistic toxicity is claimed or demonstrated (P=Plants, I=Insects, F=Fungi, N=Nematodes)

Column 8: Applicant/assignee of the patent (D=Dow, M=Monsanto, S=Syngenta, B=Bayer, Du=Dupont, Bf=BASF)

Columns 9-12: Repeat columns 5-8

Columns 13-16: Repeat columns 5-8

References Cited

- ¹ 7 U.S.C. § 136a(c)(5)(C), (D); 40 C.F.R. § 152.112(e).
- ² EPA. Pesticide Registration: Data Requirements for Pesticide Registration. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/data-requirements-pesticide-registration#nto>.
- ³ Cox, C., and Sorgan, M. (2006) Unidentified inert ingredients in pesticides: implications for human and environmental health. *Environ Health Perspect*, 114(12), 1803-1806.
- ⁴ EPA. Pesticide Registration: Pesticide Registration Manual: Chapter 1 - Overview of Requirements for Pesticide Registration and Registrant Obligations. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/pesticide-registration-manual-chapter-1-overview-requirements-pesticide#adjuvants>.
- ⁵ Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L., Scott, J.C., Stackelberg, P.E., Thelin, G.P., Wolock, D.M. (2006) Pesticides in the Nation's Streams and Ground Water, 1992-2001: U.S. Geological Survey Circular 1291. Available at: <http://pubs.usgs.gov/circ/2005/1291/>.
- ⁶ Lydy, M., Belden, J., Wheelock, C., Hammock, B., Denton, D. (2004) Challenges in regulating pesticide mixtures. *Ecology and Society* 9(6): 1. Available at: <http://www.ecologyandsociety.org/vol9/iss6/art1/>.
- ⁷ EPA. (2000) Supplementary guidance for conducting health risk assessment of chemical mixtures. EPA/630/R-00/002. Accessed 6/21/2016. Available at: <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=20533>.
- ⁸ Respondents' Motion for Voluntary Vacatur and Remand filed in *Natural Resources Defense Council, Inc. v. U.S. EPA*, No. 14-73353 (consolidated with 14-73359), ECF Dkt. No. 121 (filed November 24, 2015 9th Cir.).
- ⁹ 35 U.S.C § 103.
- ¹⁰ Instead of identifying all of the products that were approved in the last six years that have multiple active ingredients, we decided to focus our analysis on just four companies. Our reasoning is that the EPA's pesticide product label database is of limited utility. The only search terms are "product name," "company name" or "EPA registration number." The only way to identify all products approved by date is to search by company, so we focused our analysis on the major players in the agrichemical business.
- ¹¹ The 47 USPTO patent application numbers are: 13014909, 11028776, 12074809, 14172201, 12945099, 12675156, 8930901, 12066894, 9968175, 13715230, 14102818, 12936700, 11793763, 13209926, 10486663, 11628145, 12913235, 9968173, 12633063, 14215205, 13099552, 13751021, 10496185, 10170902, 10496187, 7792845, 12147853, 14567574, 12506456, 13841457, 8799310, 11028769, 11563240, 14183671, 12374195, 12374219, 11912773, 12663273, 13061976, 14026902, 13014869, 10508208, 12278731, 13790375, 12306870, 13902364 and 12824951.
- ¹² Usage information was collected from the USGS National Water-Quality Assessment (NAWQA) Program. Pesticide National Synthesis Project – annual pesticide use maps 2013. Available here: https://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php. High use ingredients (defined as more than one million pounds active ingredient used in the agricultural sector per year in the U.S.) covered by the identified patent applications include: 2,4-D, thiamethoxam, acetochlor, clopyralid, atrazine, mesotrione, S-metolachlor, chlorothalonil, imidacloprid, clothianidin, dicamba, glyphosate, azoxystrobin, bromoxynil.
- ¹³ EPA. Regulations.gov docket number EPA-HQ-OPP-2014-0355. Bicyclopyrone: New Proposed Tolerance in/on Corn commodities and a New Proposed Import Tolerance in/on Sugarcane. Available at: <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2014-0355>.
- ¹⁴ EPA. (2015) Bicyclopyrone: Response to Public Comments on EPA's "Proposed Registration of the New Active Ingredient Bicyclopyrone." Document ID: EPA-HQ-OPP-2014-0355-0076. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0076>.
- ¹⁵ EPA. Memorandum. (2015) Environmental Fate and Ecological Risk Assessment for Use of the New

Herbicide Bicyclopyrone (NOA449280). Document ID: EPA-HQ-OPP-2014-0355-0015. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0015>.

¹⁶ The United Soybean Board. Take Action. Herbicide Classification Chart. Accessed 6/22/2106. Available at: <http://takeactiononweeds.com/wp-content/uploads/herbicide-classification-chart-2016.pdf>.

¹⁷ Abendroth, J.A., Martin, A.R., Roeth, F.W. (2006) Plant Response to Combinations of Mesotrione and Photosystem II Inhibitors. *Weed Technology*, 20(1), 267-274.

¹⁸ Woodyard, A., Bollero, G., Riechers, D. (2009) Broadleaf Weed Management in Corn Utilizing Synergistic Postemergence Herbicide Combinations. *Weed Technology*, 23(4), 513-518.

¹⁹ Sutton, P., Richards, C., Buren, L., Glasgow, L. (2002) Activity of mesotrione on resistant weeds in maize. *Pest Manag Sci*, 58(9), 981-984.

²⁰ Bollman, S.L., Kells, J.J., Penner, D. (2006) Weed Response to Mesotrione and Atrazine Applied Alone and in Combination Preemergence. *Weed Technology*, 20(4), 903-907.

²¹ Hugie, J., Bollero, G., Tranel, P., Riechers, D. (2008) Defining the Rate Requirements for Synergism between Mesotrione and Atrazine in Redroot Pigweed (*Amaranthus retroflexus*). *Weed Science*, 56(2), 265-270.

²² Walsh, M., Stratford, K., Stone, K., Powles, S. (2012) Synergistic Effects of Atrazine and Mesotrione on Susceptible and Resistant Wild Radish (*Raphanus raphanistrum*) Populations and the Potential for Overcoming Resistance to Triazine Herbicides. *Weed Technology*, 26(2), 341-347.

²³ Syngenta. (2015) Acuron Technical Bulletin. Acuron™ corn herbicide defeats tough weeds current products are missing, Page 22. Downloaded on 6/30/2016 from: <http://www.syngentacropprotection.com/prodrender/imagehandler.ashx?ImID=d40b0089-7648-491d-9d4f-c4f1c92d27bb&fTy=0&et=8>. PDF of bulletin is on file with the authors.

²⁴ The Center has initiated litigation challenging the EPA's failure to consider the impacts of this approval on threatened and endangered species. See https://www.biologicaldiversity.org/news/press_releases/2015/pesticides-06-18-2015.html.

²⁵ Dow Agrosciences LLC, Wang, Peng, Huang, Jim X., Dripps, James E., Yu, Alisa Y. (WO2015196339) SYNERGISTIC EFFECT OF SPINETORAM AND METHOXYFENOZIDE FOR CONTROL OF STEM BORER ON RICE. International patent application # PCT/CN2014/080526, filed June 23rd, 2014.

²⁶ USPTO. USPTO Will Begin Publishing Patent Applications. November 27th, 2000. Available at: <http://www.uspto.gov/about-us/news-updates/uspto-will-begin-publishing-patent-applications>.

²⁷ Bayer Cropscience LP, Reid, Byron L, Baker, Robert B, Bao, Nanggang N, Koufas, Deborah A, Kent, Gerald J, Baur, Peter. (Patent # 8,404,260). Synergistic pesticide compositions. USPTO Application number 12/410,840, filed March 25th 2009. This is an example of a patent application that demonstrates synergy between the active ingredient imidacloprid and commonly used inert ingredients.

²⁸ 40 C.F.R. § 159.195(a).

²⁹ 7 U.S.C. § 136d(a)(2).

³⁰ Found here: <https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>.

³¹ Found here: <https://patents.google.com/>.

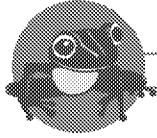
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³⁶ Colby, S.R. (1967) Calculating Synergistic and Antagonistic Responses of Herbicide Combinations. *Weeds*, 15(1), 20-22.



September 12, 2016

Office of Pesticide Programs
Environmental Protection Agency Docket Center (EPA/DC)
EPA West Building, Room 3334
1301 Constitution Ave NW
Washington, DC 20460-0001

**Re: Comments on EPA Opening the Registration Review Docket – Dicamba
(Docket #: EPA-HQ-OPP-2016-0223)**

Please accept the following comments on behalf of the Center for Biological Diversity (“Center”) in response to the Environmental Protection Agency’s (“EPA”) opening the registration review docket for dicamba under the Federal Insecticide, Fungicide, and Rodenticide Act (“FIFRA”). The Center previously submitted comments on a new use of dicamba on herbicide-tolerant cotton and soybean (Docket #: EPA-HQ-OPP-2016-0187) and incorporates those comments by reference.

The Center for Biological Diversity (“Center”) is a non-profit environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has more than one million members and online activists dedicated to the protection and restoration of endangered species and wild places. The Center has worked for twenty-six years to protect imperiled plants and wildlife, open space, air and water quality, and overall quality of life. The Center’s Environmental Health Program aims to secure programmatic changes in the pesticide registration process and to stop toxic pesticides from contaminating fish and wildlife habitats. We appreciate the opportunity to provide comment.

Before the EPA can make a supportable decision to authorize additional uses of this pesticide, it must first accomplish all of the following:

1. Comply with duties under Section 7 of the Endangered Species Act (ESA),¹ including completion of consultation.

As a separate, discretionary action that may affect endangered and threatened species, the EPA cannot approve new uses prior to the completion of consultations with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (“the Services”). Without such consultation, the EPA cannot satisfy its duty to insure that its action does not jeopardize the continued existence of imperiled species across the country or adversely modify or destroy their critical habitat. Moreover, unless and until the EPA completes ESA consultation, any taking of protected species from the use of this pesticide is unlawful.

Section 7(a)(2) of the Endangered Species Act (“ESA”) requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary . . . to be critical.”² Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.³ Indeed, the EPA’s recently finalized policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.⁴ The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.⁵ The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement.”⁶ Accordingly, the EPA must consult with the Services on its continuing and ongoing authority over this pesticide to satisfy its duty to insure that its use will not jeopardize or adversely modify protected species or their critical habitat well *before* it proposes a registration review decision. *See* Endangered Species Act Consultation Obligations for Pesticide Approvals by the Environmental Protection Agency (enclosed).

The EPA must consult on all synergistic and cumulative uses. The EPA must insure that all uses of this pesticide do not jeopardize species protected by the ESA or adversely modify or destroy their critical habitat, including uses with other ingredients or other pesticides. Absent

¹ 16 U.S.C. § 1536.

² 16 U.S.C. § 1536(a)(2) (emphasis added).

³ 50 C.F.R. § 402.14(a).

⁴ http://www.epa.gov/oppfead1/cb/csb_page/updates/2013/esa-regreview.html

⁵ 50 C.F.R. § 402.14(a).

⁶ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

information or data to determine whether dicamba will act synergistically with other ingredients, such uncertainty requires that the EPA decline to re-register any end use products containing more than one active ingredient and prohibit tank mixing on the labels.

At a minimum, where a product may affect listed species, all product labels must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁷

2. Require that that the registrant provide all necessary data and studies.

The EPA must have substantial evidence to re-register this pesticide. To do so, the EPA must require all necessary data and studies, including, but not limited to any previously identified data or study gaps, additional studies to evaluate effects on pollinators in accordance with the *Guidance for Assessing Pesticide Risks to Bees*,⁸ information concerning estrogen or other endocrine disruption effects,⁹ and any information that this pesticide or products containing this pesticide may have synergistic effects.

3. Incorporate necessary factors into evaluation and any proposed decision.

These factors should include the following, at a minimum:

- a. effects on species listed as protected under the ESA and their critical habitat,
- b. effects on pollinators and other beneficial insects,
- c. effects on human health or environmental safety concerning endocrine disruption, and
- d. any additive, cumulative or synergistic effects of the use of this pesticide.

⁷ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

⁸ EPA 2014. *Guidance for Assessing Pesticide Risks to Bees*. Available at https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf

⁹ See 21 U.S.C. §§ 346a(d)(2)(A)(x) and 346a(p).

EPA cannot propose a registration review decision under FIFRA (often described as “interim”) and satisfy its legal duties unless it requires sufficient information and evaluates it for adverse effects before reaching any conclusions.

Congress tasked the EPA with regulation of pesticides for safe use. FIFRA authorizes EPA to register a pesticide only upon determining that the pesticide “will perform its intended function without unreasonable adverse effects on the environment,” and that “when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse effects on the environment.”¹⁰ The statute defines “unreasonable adverse effects on the environment” to include “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.”¹¹ The EPA cannot meet this standard without requiring, evaluating and considering all information that causes adverse effects from the additional use of this pesticide. *Pollinator Stewardship Council v. U.S. E.P.A.*, Case No. 13-72346, Dkt. No. 58-1 at 6, 2015 WL 5255016, *1.

4. Place appropriate restrictions on uses to avoid and minimize adverse effects.

The EPA has broad authority to restrict uses and place strong mitigation language on labels to avoid adverse effects and when there is uncertainty.

5. The EPA Needs to Take Into Account Real-world Scenarios.

The EPA often claims that it is acting conservatively by using the maximum labeled use rates when estimating exposure to plants and animals. These upper-level exposure scenarios, however, do not take into account accidental spills and illegal uses of the pesticide.

A recent survey of farmers in Missouri indicated that less than half -- only 43 percent -- actually read the label each time they use pesticides.¹² Sixteen percent only read the label half the time or less and 1.2 percent have never read the label at all. Pesticide labels also have wind speed requirements that are meant to reduce drift and are used in EPA’s risk assessment process to estimate off-site exposure. Four percent of pesticide applicators never checked the wind speed before application and 40 percent of applicators checked wind speed by looking at trees, a very unreliable form of measurement that is often inaccurate.

Therefore, the ever-present possibility of an accidental spill indicates that this is a reasonably foreseeable event that should be accounted for when estimating peak exposure concentrations. In

¹⁰ 7 U.S.C. § 136a(e)(5)(C), (D); 40 C.F.R. § 152.112(e).

¹¹ 7 U.S.C. § 136(bb).

¹² Randall. July 13th, 2016. State news. *57 percent of those applying pesticides in Missouri do not read label instructions*. Available at: <http://www.kttm.com/57-percent-of-those-applying-pesticides-in-missouri-do-not-read-label-instructions/>.

addition, the small amount of data that are available on label compliance indicate that it is unreasonable to assume that pesticides are always applied in accordance with the label. We feel that when communicating findings to a risk manager, the EPA no longer refer to its use of maximum labeled rates as “conservative” or accurately estimating peak exposures that may occur.

6. The EPA needs to take into account increased use of dicamba in its risk assessments.

The EPA’s risk assessment approach is not designed to analyze risk due to increased total usage of a pesticide compared to current levels. It is simply designed to estimate exposure to a single chemical based on labeled usage rates on specific crops. This exposes one of the great shortcomings in EPA’s risk assessment approach – it is very short sighted. It takes a narrow approach of assessing risk without taking into account the bigger picture of total usage of a particular pesticide or combined usage of multiple pesticides. Therefore, risk is typically underestimated and potential increases in total pesticide usage are not accurately assessed for potential harms.

The EPA recognized this when proposing to register dicamba for use on dicamba-resistant cotton and soy and stated that “[a]lthough the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications.”¹³ And, “[t]hough the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans.”¹⁴

Dicamba use is on the rise and if the EPA approves the “new use” of dicamba on dicamba-tolerant cotton and soybeans it will result in an even greater increase.^{15,16} Monsanto did an

¹³ EPA. Memorandum. Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). Docket ID: EPA-HQ-OPP-2016-0187-0008.

¹⁴ EPA. Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean. Docket ID EPA-HQ-OPP-2016-0187-0016.

¹⁵ EPA. Memorandum. Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 8770 I). Docket ID EPA-HQ-OPP-2016-0187-0005. Page 36.

¹⁶ Mortensen, DA, Egan, JF, Maxwell, BD, Ryan, MR, Smith, RG. Navigating a Critical Juncture for Sustainable Weed Management. *BioScience* (2012) 62 (1): 75-84. doi:10.1525/bio.2012.62.1.12. and Bohnenblust, EW, Vaudo,

analysis on the possible future increase in use of dicamba for USDA when applying for deregulation of genetically engineered (“GE”) dicamba/glyphosate resistant soybean and cotton. Monsanto predicted that annual commercial dicamba use on soybeans would increase from 233,000 pounds in 2011 to 20.5 million pounds at the time of peak (40%) GE crop adoption.¹⁷ This is a nearly 100-fold increase in dicamba usage just on soybean and could be even higher if these GE crops are more widely adopted. Similar projections were made for dicamba use on cotton from 364,000 pounds applied annually in 2011 to 5.2 million pounds at the time of peak (50%) adoption.¹⁸ Assuming peak adoption of dicamba resistant soybean and cotton would occur in the next 3-4 years, the U.S. is looking at a more than 25 million pound increase in dicamba usage for these two crops by 2020.

Although this is likely an underestimate, as crop adoption rates will likely be much higher and current labels actually urge users to spray higher than typical rates to slow weed resistance, it is a starting point for the EPA to begin to analyze the effects of total pesticide load on human and environmental health. This increase in dicamba usage would not likely displace other herbicide use. The EPA needs to view registration decisions as not only a way to analyze the effects of labeled pesticide usage, but also as a way to ensure that total pesticide use does not increase. The EPA could take this into account in the cost-benefit analysis by analyzing the associated costs of labeled pesticide use as well as the costs associated with total pesticide load in the environment.

There are many parallels here with what happened with glyphosate in the 1990’s. In 1993, the EPA re-registered glyphosate with the finding that labeled use of glyphosate would not cause unreasonable adverse effects on the environment. Of course, a couple of years later the widespread adoption of “Roundup Ready” GE crops resulted in an exponential increase in glyphosate use from around 10 million pounds to around 300 million pounds per year in 25 years.¹⁹ This resulted in many unforeseen environmental problems, most notably by playing a large role in the dramatic decline of the Monarch butterfly. The rapid rise in glyphosate has destroyed Monarch habitat across most of the Midwest and the Monarch is currently being considered for a “threatened” listing under the Endangered Species Act. Glyphosate’s affect on the Monarch was not even discussed in the 1993 ERA for glyphosate. But it happened. There are

AD, Egan, JF, Mortensen, DA, Tooker, JF. Effects of the herbicide dicamba on nontarget plants and pollinator visitation. *Environ Toxicol Chem.* (2016) 35(1): 144-51. doi: 10.1002/etc.3169.

¹⁷ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS appendix, Table 4-9 and page 4-16.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁸ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS Appendix, Table 4-12 and page 4-19.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁹ USGS. *U.S. Geological Survey: Pesticide National Synthesis Project, pesticide use maps-glyphosate.* 2014. [Accessed on 09/12/2016]; Available from: https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2014&map=GLYPHOSATE&hilo=L&disp=Glyphosate.

two reasons for this: 1) the glyphosate ERA did not analyze indirect effects, like those on the milkweed plant that the Monarch is completely reliant on and 2) the EPA did not analyze how such a quick increase in total glyphosate usage would affect the environment. In its dicamba analysis, the EPA needs to fix these two shortcomings in its ERA process and accurately analyze how the inevitable increase in dicamba load in the environment, in combination with glyphosate, will affect human health and the environment.

7. The EPA needs to assess the enhanced toxicity of pesticide mixtures.

The EPA has made no mention of whether it intends to finally do a robust mixture analysis in the upcoming registration review docket. It has long been the EPA's policy to not do a mixture analysis because it's just too darn hard. Yet there is never any mention that this decision essentially results in the default assumption that all mixtures involving dicamba have the exact same toxicity as dicamba alone, a completely scientifically-unjustified assumption. The EPA is constantly saying that there are never enough data and that they lack the methodology to do a robust analysis. But the agency completely ignores the fact that by approving so many multi-ingredient formulations and allowing countless numbers of tank mixtures to occur, it is essentially enabling the existence of all of these mixtures without any data whatsoever that it can be done safely. These are not the actions of an agency that is confident in its abilities to protect the health of humans and the environment; these are the actions of an agency that is in way over its head.

The Center for Biological Diversity recently released a report²⁰ analyzing an unconventional new source of much needed data – patent applications. When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant. For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

We conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta). Our key finding was that 69 percent of these products (96 out of 140) had at least one patent application

²⁰ Donley, N. (2016). Toxic Concoctions: How The EPA Ignores The Dangers Of Pesticide Cocktails. Retrieved from The Center for Biological Diversity website: http://www.biologicaldiversity.org/campaigns/pesticides_reduction/pdfs/Toxic_concoctions.pdf. Submitted to the docket with comment letter.

that claimed or demonstrated synergy between the active ingredients in the product.

There were 11 multi-ingredient products containing dicamba that were approved in the past six years from these four companies.²¹ Of those 11, ten have evidence of synergy between the active ingredients in the product. The identified patent applications in our report found synergistic toxicity to plants from the combinations of:

- 1) Dicamba and glyphosate (U.S. patent application numbers 13099552 and 13751021)
- 2) Dicamba and penoxsulam (U.S. patent application number 14026902)
- 3) Dicamba and Isoxaben/indaziflam (U.S. patent application numbers 13841457 and 12506456)

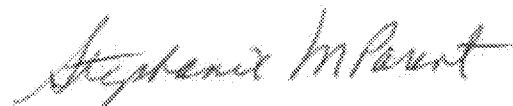
None of these patent applications were discussed in any documents in the docket despite being directly relevant to the analysis at hand. Since most products that contain dicamba were approved more than six years ago, our analysis would not have identified other patent applications or studies that may be relevant to other dicamba products.

This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them.

Therefore, in order to be compliant with FIFRA, the EPA must do an analysis of mixture toxicity with mixtures containing dicamba before a re-registration decision can be made.

If the EPA does not think that it has the proper methodology in place to do this analysis, prohibiting the co-application of certain pesticides with dicamba through label changes and cancelling certain products that contain these mixtures is another way the EPA can ensure that any registration decision is compliant with FIFRA. Otherwise, the EPA will not be able to conclude that the continued use of dicamba will not have unreasonable adverse effects on the environment.

Respectfully submitted,



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²¹ *Id.* at Appendix B



ENDANGERED SPECIES ACT CONSULTATION OBLIGATIONS FOR PESTICIDE APPROVALS BY THE ENVIRONMENTAL PROTECTION AGENCY

I. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on Pesticide Approvals.

Section 7(a)(2) of the ESA requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary... to be critical.”²² Under Section 7(a)(2), the EPA must consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service (collectively the “Services”) to determine whether its actions will jeopardize listed species’ survival or adversely modify designated critical habitat, and if so, to identify ways to modify the action to avoid that result.²³ The consultation requirement applies to any discretionary agency action that may affect listed species.²⁴ Because the EPA may decline to approve pesticides and uses, its decision represents a discretionary action that clearly falls within the ESA’s consultation requirement.²⁵

The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.²⁶ Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.²⁷ Indeed, the EPA’s policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.²⁸ The Services define “may affect” as “the appropriate conclusion when a proposed action may pose *any* effects on listed species or designated critical habitat.”²⁹ This inquiry even includes beneficial effects. The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character,

²² 16 U.S.C. § 1536(a)(2) (emphasis added).

²³ 50 C.F.R. § 402.14.

²⁴ *National Association of Home Builders v. Defenders of Wildlife*, 551 U.S. 644 (2007).

²⁵ See *Washington Toxics Coalition v. EPA*, 413 F. 3d 1024, 1032 (9th Cir. 2005) (“even though EPA registers pesticides under FIFRA, it must also comply with the ESA when threatened or endangered species are affected.”).

²⁶ 50 C.F.R. § 402.14(a).

²⁷ 50 C.F.R. § 402.14(a).

²⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013) at p. 8

²⁹ U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998, *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* (hereafter CONSULTATION HANDBOOK) at xvi (emphasis in original).

triggers the formal consultation requirement.”³⁰ For this initial stage of review, exposure to a pesticide does not require that effects reach a pre-set level of significance or intensity to trigger the need to consult (e.g. effects do not need to trigger population-level responses). As the Services’ joint consultation handbook explains, an action agency such as the EPA may make a “no effect” determination, and thus avoid undertaking informal or formal consultations, only when “the action agency determines its proposed action will not affect listed species or critical habitat.”³¹

Because the use of these pesticide formulations and products “may affect” listed species and “may affect” the critical habitat of listed species, the EPA must consult with the Services regarding its pesticide approvals in order to comply with the ESA.

Fortunately the National Academy of Sciences (“NAS”) has provided guidance regarding the obligations of EPA and other wildlife agencies in analyzing pesticide approvals under the ESA. The NAS committee provided a report to the EPA and Services in April of 2013 providing specific recommendations relating to the use of “best available data,” methods for evaluating sublethal, indirect, and cumulative effects; the state of the science regarding assessment of mixtures and pesticide inert ingredients; the development, application, and interpretation of results from predictive models; uncertainty factors; and what constitutes authoritative geospatial and temporal information for the assessment of individual species, habitat effects and probabilistic risk assessment methods.³²

While the NAS report outlines areas for all three agencies to improve, the NAS report made several significant conclusions about the current ecological risk assessment process and its use of risk quotients (“RQs”), including:

- The EPA “concentration-ratio approach” for its ecological risk assessments “is ad hoc (although commonly used) and has unpredictable performance outcomes.”³³
- “RQs are not scientifically defensible for assessing the risks to listed species posed by pesticides or indeed for any application in which the desire is to base a decision on the probabilities of various possible outcomes.”³⁴
- “The RQ approach does not estimate risk...but rather relies on there being a large margin between a point estimate that is derived to maximize a pesticide’s environmental concentration and a point estimate that is derived to minimize the concentration at which a specified adverse effect is not expected.”³⁵

³⁰ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

³¹ CONSULTATION HANDBOOK at 3-13.

³² National Academy of Sciences 2013. *Assessing Risks to Endangered and Threatened Species from Pesticides* (hereafter NAS REPORT), Committee on Ecological Risk Assessment under FIFRA and ESA Board on Environmental Studies and Toxicology Division on Earth and Life Studies National Research Council (April 30, 2013).

³³ *Id.* at 107.

³⁴ *Id.* at 11.

³⁵ *Id.*

- “Adding uncertainty factors to RQs to account for lack of data (on formulation toxicity, synergy, additivity, or any other aspect) is unwarranted because there is no way to determine whether the assumptions that are used overestimate or underestimate the probability of adverse effects.”³⁶

According to the NAS, the EPA concentration-ratio approach contrasts sharply with a probabilistic approach to assessing risk, which the NAS describes as “technically sound.” The NAS’s underlying conclusion is that EPA should move towards a probabilistic approach based on population modeling, an approach that the NMFS already utilizes.³⁷ The NAS also recommends that the FWS move towards a probabilistic approach in its consultations.

Following the publication of the NAS report, the agencies have developed two policy documents to guide consultations on pesticide review and approvals moving forward: (1) *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes*,³⁸ and (2) *Interim Approaches for National-level Pesticide Endangered Species Act Assessments Based on Recommendations of the National Academy of Science April 2013*.³⁹ The agencies made clear at a November 15, 2013 public meeting that these new procedures and approaches would be “day forward” in their implementation.⁴⁰ Accordingly, approvals of pesticides and uses *must* follow these new *Interim Approaches* and comply with the requirements of the ESA.

A. Completion of Step One under Interim Approaches

As laid out in the National Academy of Sciences and *Interim Approaches* guidance, the risk assessment and consultation process should follow three steps.⁴¹ These steps generally follow the three inquiries of the ESA consultation process: (1) the “no effect”/ “may affect” determination (2) the “not likely to adversely affect”/ “likely to adversely affect” determination (3) the jeopardy/no jeopardy and adverse modification/no adverse modification of critical habitat determination. Step One generally follows the requirements of the ESA and will in most cases identify those species at risk from pesticides that need additional review through the informal and formal consultation process. At Step One, the EPA must gather sufficient data to complete the following two related inquiries: (1) the EPA must determine whether pesticide use areas will overlap with areas where listed species are present, including whether a use area overlaps with any listed species’ critical habitat (2) the EPA must determine whether off-site transport of pesticides will overlap with locations where listed species are present and/or critical habitat is designated. Off-site transport must include considerations of downstream transport due to runoff

³⁶ *Id.*

³⁷ *Id.* at 107.

³⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013).

³⁹ Available at <https://www.epa.gov/sites/production/files/2015-07/documents/interagency.pdf>

⁴⁰ INTERAGENCY APPROACH FOR IMPLEMENTATION OF NATIONAL ACADEMY OF SCIENCES REPORT: ASSESSING RISKS TO ENDANGERED AND THREATENED SPECIES FROM PESTICIDES, Public Meeting Silver Spring NOAA Auditorium (Nov. 15, 2013).

⁴¹ NAS REPORT at 37-38.

as well as downwind transport due to spray drift when the best available science indicates such transport is occurring.⁴²

What the EPA should do to meet the legal requirements of the ESA is use the best available spatial data regarding the pesticide use patterns and the distribution and range of listed species to determine whether a pesticide's use overlaps with species, and then make a "may affect"/"no effect" determination. The Fish and Wildlife Service ECOS website provides GIS-based data layers for each listed species with designated critical habitat.⁴³ These maps are scalable and can achieve the precision needed to make accurate effects determinations regarding whether a pesticide will have "no effect" or "may affect" a listed species and are certainly accurate enough to make determinations as to whether the use of a pesticide represents adverse modification of critical habitat. Figure One provides an overlay map from ECOS of all critical habitat that has been designated for listed species thus far.

Other sources provide additional data on the distribution and life history of threatened and endangered species. NatureServe provides detailed life history information, including spatial distribution, for native species across the United States.⁴⁴ In addition, many State governments collect detailed information on non-game species through their State Wildlife Action Plans.⁴⁵ In short, there are many sources of data that can provide EPA with the detailed information it needs to conduct an effects determination for each species. If there is a subset of species where it believes information is still lacking, EPA should make that clear to all stakeholders which species specifically it believes such data are lacking early in the process such that this information can be collected from the Services and other sources.

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⁴² The Center acknowledges that in many areas, atmospheric transport is difficult to model and assess. However, in some areas, the impacts of atmospheric transport of pesticides are well understood. A recent study found that a variety of pesticides are accumulating in the Pacific chorus frogs (*Pseudacris regilla*) through atmospheric deposition at remote, high-elevation locations in the Sierra Nevada mountains, including in Giant Sequoia National Monument, Lassen Volcanic National Park, and Yosemite National Park Smalling, K.L., et al. 2013. *Accumulation of Pesticides in Pacific Chorus Frogs (Pseudacris regilla) from California's Sierra Nevada Mountains*, Environmental Toxicology and Chemistry, 32:2026–2034.

⁴³ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁴ NatureServe Get data. <http://www.natureserve.org/getData/index.jsp>

⁴⁵ State Wildlife Action Plans. <http://teaming.com/state-wildlife-action-plans-swaps>

Figure One – Base Composite Map of Critical Habitat in the United States⁴⁶



To make scientifically valid effects determinations, EPA will also need the best available spatial data regarding the use of pesticides. The U.S. Department of Agriculture and the U.S. Geological Survey⁴⁷ collect data on an enormous suite of pesticide active ingredients each year, as do several private organizations. Thus, it should be possible to determine where areas of geographic overlap between species and pesticide usage occur. If empirical data on pesticide use or persistence in the environment is lacking geospatial modeling can be used to determine where pesticide use may overlap with affected endangered species.

With the completion of the problem formulations for Ecological Risk, the EPA should now move quickly to begin the informal consultation process for pesticides, starting with a spatial analysis as envisioned as Step one. If this information is collected and assessed properly, then it should then be relatively straightforward for the EPA to begin to develop geographic restriction on the use of pesticides wherever designated critical habitat for a listed species exists as parts of Step Two and Step Three. However, because not all threatened and endangered species have critical

⁴⁶ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁷ USGS, National Water-Quality Assessment (NAWQA) Program, Pesticide National Synthesis Project, Annual Pesticide Use Maps: 1992-2013, available at <https://water.usgs.gov/nawqa/pnsp/usage/maps/>

habitat, the EPA will also have to collect data on the distribution and range of species that do not yet have critical habitat to determine whether the use of these pesticides will jeopardize any of those species.

B. Label Requirements.

FIFRA requires that the EPA evaluate and reregister a pesticide every 15 years. During that 15 year period, crop distributions change, use patterns for pesticides change, and listed species change. By the time the registration review process is complete several years from now, additional species will almost certainly be protected by the ESA. Of the species currently listed, some may move towards recovery and become more common while others may become even more imperiled.

Product labels must be able to adapt to changing conditions on the ground to ensure that the use of these pesticides do not cause unanticipated adverse impacts that result in levels of take not authorized through the Section 7 consultation process. Fortunately, the EPA has already developed a system that can address impacts to endangered species and that provides for geographically-targeted conservation measures on the ground through its *Bulletins Live! Two* website.⁴⁸ The Center recommends that whenever a pesticide may affect listed species, both as a precautionary matter and as a mechanism to implement any conservation measures that are implemented in the informal and formal consultation process, the EPA use the *Bulletins Live! Two* system to incorporate these measures. Accordingly, all product labels for pesticides affecting endangered species must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁴⁹

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⁴⁸ U.S. Environmental Protection Agency Endangered Species Protection Bulletins.

<http://www.epa.gov/espp/bulletins.htm>

⁴⁹ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

II. The EPA Must Make Defensible “Not Likely to Adversely Affect” and “Likely to Adversely Affect” Determinations as a Prerequisite for Defensible “Jeopardy” and “No Jeopardy” Determinations.

At the informal consultation stage, the EPA must determine whether the use of a pesticide is either “not likely to adversely affect” (“NLAA”) a listed species or is “likely to adversely affect” (“LAA”) a listed species.⁵⁰ The Services define NLAA as “when effects on listed species are expected to be discountable, insignificant, or completely beneficial.” Discountable effects are those that are extremely unlikely to occur and that the Services would not be able to meaningfully measure, detect, or evaluate” because of their insignificance⁵¹ In the context of pesticides, only if predicted negative effects are discountable or insignificant can the EPA avoid the need to enter formal consultations with the Services. This is *not* a high threshold. The EPA is not required to make a determination as to whether exposure to a pesticide results in population level changes in order to request formal consultations. The Center believes that the Step Two approach described is generally compatible with the mandates of the ESA regarding actions that may affect listed species. The one in a million mortality threshold for “likely to adversely affect” reflects the ESA’s and the Consultation Handbook’s requirements. The decision to consider 1) sublethal effects to species, 2) additive, synergistic and cumulative effects of all chemicals and non-chemical stressors present in the pesticide formulation, tank mixture, and the environment, 3) and the fate and action of pesticide degradates at Step Two is also consistent with the ESA’s requirements and represents an important change from the previous EPA approach, in which the EPA was making policy judgments at Step Two as to whether known, adverse, population-level impacts crossed a severity threshold to warrant consultations.

Finally, the Center notes that at Step Three, the formal consultation process, the EPA and Services must consider the environmental baseline as well as all cumulative effects when determining if the approval pesticides, formulations, or uses will jeopardize any threatened or endangered species. The Services define environmental baseline as “the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process.”⁵² Cumulative effects are defined as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.”⁵³ Pesticide consultations must consider the interactions between the active ingredient under review and other pollutants in the present in the environment.

The Food Quality Protection Act of 1996 (“FQPA”) requires EPA to measure risk of a pesticide based on “... available information concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity.” The EPA has

⁵⁰ U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act*. at 3-1.

⁵¹ *Id.* at xv.

⁵² *Id.* at xiv.

⁵³ *Id.* at xiii.

interpreted this to mean that only pesticides with a common mechanism of action be assessed in a cumulative risk assessment. We strongly disagree with this interpretation. First, the term “other substances” can include chemicals other than pesticides and also stressors that are not chemicals, like radiation and climate change. The EPA itself defines cumulative risk as “the combined risks from aggregate exposures to multiple agents or stressors,” where agents or stressors can be chemicals or “may also be biological or physical agents or an activity that, directly or indirectly, alters or causes the loss of a necessity such as habitat.”⁵⁴ Second, the term “common mechanism of toxicity” does not dictate that the EPA only consider agents or stressors with a common mechanism of action. The National Research Council has recommended that the EPA use the endpoint of common adverse outcome rather than common mechanism of action to group agents that could act cumulatively.⁵⁵ As for how this relates to EPA’s duty under the ESA, cumulative risk in the ESA needs to be interpreted very broadly as this piece of legislation is a precautionary document meant to ensure that no harm comes to listed species. Although the EPA interprets the scope of cumulative risk assessments under FQPA to be limited to the common mechanism effect, **there is absolutely no such written or intended limit in the ESA**. The EPA needs to begin discussions on how it will test true cumulative risk, the way it is broadly defined in the ESA, because current metrics and protocols that measure cumulative risk under FQPA are inadequate for the EPA to meet its legal obligations under the ESA.

Pesticide and their residues and degradates do not occur in single exposure situations and many different mixtures of pesticides occur in water bodies at the same time.⁵⁶ The mixtures of these chemicals can combine to have additive or synergistic effects that are substantially more dangerous and increase the toxicity to wildlife.⁵⁷ Thus, to fully understand the ecological effects and adverse impacts, the EPA and the Services must consider the pesticide’s use in the context of *current* water quality conditions nationwide. In particular, the use of pesticides in watersheds that contain threatened or endangered species and where water quality is already impaired could be particularly problematic. Therefore, the agencies must use the best available data to fully inform its ecological risk assessment by considering water quality.

In conclusion, the EPA should move quickly to assemble the needed spatial data to make an informed “no effect” or “may affect” finding for *each* listed species that will likely overlap with the use of these pesticides or come into contact with its environmental degradates. If there is overlap, EPA must at a minimum conclude that the use of these pesticides “may affect” listed species. Where this occurs, EPA has a choice—(1) the EPA can elect to complete an informal consultation through a biological assessment (also known as a biological evaluation), or (2) the EPA can undergo formal consultation with the Services. If EPA completes a biological

⁵⁴U.S. Environmental Protection Agency 2003. Framework for Cumulative Risk Assessment. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/P-02/001F, 2003. Pg. xvii.

⁵⁵ National Research Council (US) Committee on the Health Risks of Phthalates. Phthalates and Cumulative Risk Assessment: The Tasks Ahead. Washington (DC): National Academies Press (US); 2008. Page 4.

⁵⁶ NMFS 2011, *Endangered Species Act Section 7 Consultation Draft Biological Opinion for the Environmental Protection Agency’s Pesticide General Permit for Discharges from the Application of Pesticides* (hereafter Draft BiOp) at 118-119, lines 4209-31; Gilliom, R.J. et al. 2006. *Pesticides in the Nation's Streams and Ground Water, 1992–2001—A Summary*, available at <http://pubs.usgs.gov/fs/2006/3028/>.

⁵⁷ Draft BiOp at 127-129, lines 4471-4515; Gilliom, R.J. 2007. *Pesticides in the Nation's Streams and Ground Water*, Environmental Science and Technology, 413408–3414.

assessment and implements geographically-tailored conservation measures through *Bulletins Live! Two*, it may be able to reach NLAA determinations via the informal consultation process and alleviate the need for formal consultations. In the alternative, the EPA can move directly to formal consultation after making “may affect” determinations for species where the impacts of pesticides are more complex and will take additional expertise to develop sufficient conservation measures. Cumulative effects need to be measured in Steps 2 and 3.

III. EPA and the Services Must Assess the Adverse Impacts on Critical Habitat.

Section 7 of the ESA prohibits agency actions that would result in the “destruction or adverse modification of [critical] habitat.”⁵⁸ This inquiry is separate and distinct from the question as to whether a pesticide approval will result in jeopardy to any listed species. A no jeopardy finding (or a Not Likely to Adversely Affect finding in an informal consultation) is *not* equivalent to a finding that critical habitat will not be adversely modified. While there is much overlap between these two categories (for example, as in *Tennessee Valley Authority v. Hill*⁵⁹ where the proposed agency action to build a dam would both destroy a species’ habitat and kill individual members of the species in the same time) many agency actions do result in adverse modification to critical habitat without causing direct harms to species that do rise to the level of jeopardy.⁶⁰ Indeed, the ESA’s prohibition on “destruction or adverse modification” of critical habitat does not contain any qualifying language suggesting that a certain species-viability threshold must be reached prior to the habitat modification prohibition coming into force.

As three federal circuit courts have made abundantly clear, avoiding a species’ immediate extinction is not the same as bringing about its recovery to the point where listing is no longer necessary to safeguard the species from ongoing and future threats. Therefore, Section 7 requires that critical habitat not be adversely modified in ways that would hamper the *recovery* of listed species.⁶¹ These potent pesticides with known adverse ecological effects have the potential to adversely modify critical habitat by altering ecological community structures, impacting the prey base for listed species, and by other changes to the physical and biological features of critical habitat. Accordingly, the informal consultation must separately evaluate whether these pesticide products and formulations will adversely modify critical habitat regardless of whether these pesticide products jeopardize a particular listed species. For example, if plant communities alongside a water body that has been designated as critical habitat suffer increased mortality, and this then results in increased temperatures or increased sedimentation, that would represent adverse modification of critical habitat. Likewise, if pesticides are toxic to species lower in the food chain, and a threatened or endangered species feeds on those affected prey species, this impact to the food web would represent a clear example of adverse modification to critical habitat.

⁵⁸ 16 U.S.C. § 1536(a)(2).

⁵⁹ 437 U.S. 153 (1978)

⁶⁰ See Owen, D. 2012. *Critical Habitat and the Challenge of Regulating Small Harms*. Florida Law Review 64:141-199.

⁶¹ See *Gifford Pinchot Task Force v. FWS*, 378 F.3d 1059, 1069-71 (9th Cir. 2004) (finding a FWS regulation conflating the requirements of survival and recovery to be unlawful); see also *N.M. Cattle Growers Ass’n v. FWS*, 248 F.3d 1277, 1283 n.2 (10th Cir. 2001); *Sierra Club v. FWS*, 245 F.3d 434, 441-42 (5th Cir. 2001)

EPA's evaluation must address impacts to critical habitat even if the direct effects on listed species fall below the NLAA or jeopardy thresholds. The Center recommends that the EPA design conservation measures—and implement those measures using *Bulletins Live! Two*—specifically to protect critical habitat of listed species from exposure to pesticides, and where appropriate, prohibit its use altogether in critical habitat where necessary. Doing so would provide meaningful, on-the-ground protections for hundreds of listed species, and may in some cases, help the EPA and the Services then reach a defensible NLAA or “no jeopardy” opinion.

IV. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on the Approval of All End-use Product Labels.

Just as the EPA must consult with the Services regarding the reregistration of an active pesticide ingredient, EPA must also consult with the Services regarding the registration or approval of end use and technical pesticide products. Such consultations must also occur at the earliest possible time to ensure that specific product formulations do not result in jeopardy for a listed species or adversely modify critical habitat.

In addition, because end use formulations may result in mixes of the active ingredient with “other ingredients” before application, the EPA must consider during the consultation process the effects of these “inert” or “other” ingredients together with the active ingredient on listed species and set appropriate conservation restrictions accordingly. As noted in *Washington Toxics Coalition v. U.S. Dept. of Interior*, “other ingredients” within a pesticide end product may cause negative impact to listed species even if they are less toxic than the active ingredient being reviewed.⁶² “Other ingredients,” such as emulsifiers, surfactants, anti-foaming ingredients, and fillers may harm listed species and adversely modify critical habitat. Many of the more than 4,000 potentially hazardous additives allowed for use as pesticide additives are environmental contaminants and toxins that are known neurotoxins and carcinogens.⁶³ The EPA has routinely failed to consult with the Services on the registration of “other ingredients,” potentially compounding harms to listed species by allowing such ingredients to be introduced widely into the environment. EPA must, as part of the consultation process, consider the range of potential impacts by using different concentrations and different formulations of the active ingredient, as well as the potential negative impacts of “other ingredients” used in end use products.

The National Academy of Science report recognized that without real-world considerations of where listed species are located, the relative conservation status of listed species, the environmental baseline, and the interaction of pesticides with other active ingredients, pesticide degradates, and other pollutants, the EPA risk assessment process will not be able to make meaningful predictions about which endangered species will be adversely affected. Until the EPA can conduct realistic assessments, it should take a precautionary approach and enter into formal consultations with the Services as outlined in the *Interim Approaches* document.

⁶² 457 F. Supp. 2d 1158 (W.D. Wash 2006).

⁶³ Draft BiOp at 113, lines 4062-68; 120-121, lines 4262-308; 127, lines 4445-4455; Northwest Coalition for Alternatives to Pesticides, et al., Petition to Require Disclosure of Hazardous Inert Ingredients on Pesticide Product Labels. 2006. http://www.epa.gov/opprd001/inerts/petition_ncap.pdf.

FESTF

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August 31, 2016

Ms. Marquee King
USEPA Headquarters
Ariel Rios Building
1200 Pennsylvania Avenue, N. W. - Mail Code: 7509P
Washington, DC 20460

Concerning: Active Ingredient: Dicamba Case number: 0065
Docket number: EPA-HQ-OPP-2016-0223

Dear Ms. King,

In its Registration Review Preliminary Work Plan, EPA has noted that Dicamba has not had a complete endangered species determination performed to allow the Agency to determine whether the uses have “no effect” or “may affect” federally listed species or their designated critical habitats. At such time as an endangered species evaluation is conducted by EPA, the data developed by FESTF, in response to the Agency’s endangered species data requirements, will address species proximity to Dicamba uses.

In June of 2004, March of 2005, October 19, 2007, October 12, 2012, April 22, 2013, and June 1, 2015 the FIFRA Endangered Species Task Force (FESTF, Company Number 73989) submitted its Information Management System (FESTF Information Management System (IMS): Documentation of Structure and Function of IMS 1.1, MRID # 46325901) and documentation of the beta-tested IMS, NatureServe data (FESTF Task Force Information Management System (IMS): Beta-Tested IMS 2.0 and Access to NatureServe Data - Final Report, MRID # 46486301), NatureServe Data Evaluation and Review and description of the NatureServe Dataset Licensed by FESTF (MRID #'s 47260101 and 48969501), listed species attribute and aggregated location data (MRID #'s 48969502, 48969506, 49643402), information related to the proximity of listed species to pesticide use sites (MRID #'s 48969503, 48969504, 48969505 and 49272701), and an evaluation of and access to a licensed dataset containing the spatial locations of golf courses (MRID # 49643403). Additionally, FESTF is developing maps for each federally listed species utilizing FESTF’s aggregated species location data. The species maps are being developed in three phases; Phase 1 maps were submitted on February 20, 2015 (MRID # 49575201), Phase 2 maps were submitted on June 1, 2015 (MRID # 49643401) and Phase 3 maps were submitted on March 24, 2016 (MRID # 49880801). These data fulfill the data requirements spelled out in Pesticide Registration Notice 2000-2 and provide the best available data necessary to support the analysis of Dicamba use and listed species locations and potential exposure.

MEMBER COMPANIES

ADAMA Agricultural Solutions, Ltd.
Albaugh, LLC
AMVAC Chemical Corp.
BASF Corp.
Bayer CropScience

Dow AgroSciences, LLC
DuPont Crop Protection
FMC Corp., Ag. Products
Gowan Company, LLC
ISK Biosciences Corp.

MacDermid Agricultural Solutions, Inc.
Monsanto Co.
Nichino America, Inc.
Nippon Soda Co., Ltd.
Nissan Chemical Industries, Ltd.

Nufarm Americas, Inc.
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The technical registrants, as identified on the fact sheet included in the Registration Review work plan, Monsanto Company, DuPont, BASF, Syngenta, Albaugh, MacDermid Agricultural Solutions, Inc., as the parent company for Arysta LifeScience North America, which are FESTF members and are entitled to rely on FESTF data (See Attachment A for our current list of members and companies who have reached an agreement allowing reliance on FESTF data submissions).

Sincerely,

(for)

Dan Campbell
Administrative Chairperson, FESTF
Chair, FESTF Administrative Committee
FIFRA Endangered Species Task Force, L.L.C.

cc: Joy Honegger, Monsanto Company
Richard Ambrose DuPont Crop Protection
Jeffrey Birk, BASF Corporation
Dan Campbell, Syngenta Crop Protection, Inc.
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Melinda Bowman, MacDermid Agricultural Solutions, Inc.
Grant Rowland, USEPA

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AMVAC Chemical Corp.	FMC Corp., Ag. Products	Nichino America, Inc.	Syngenta Crop Protection, Inc.
BASF Corp.	Gowan Company, LLC	Nippon Soda Co., Ltd.	Valent USA Corp.
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ATTACHMENT A

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September 13, 2016

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Dear Ms. Guilaran,

Please find enclosed Monsanto's comment on the dicamba preliminary work plan, the ecological problem formulation, and human health draft risk assessment Docket ID No. EPA-HQ-OPP-2016-0223.

Sincerely,

Jerry W. Cabbage, Ph.D.
Regulatory Affairs Manager

**COMMENTS OF MONSANTO COMPANY
ON THE DICAMBA AND DICAMBA BAPMA SALT
PRELIMINARY WORK PLAN (PWP)**

EPA-HQ-OPP-2016-0223

Submitted by:
Monsanto Company
800 North Lindbergh Blvd.
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Monsanto Comments on Dicamba and Dicamba BAPMA Salt

Preliminary Work Plan (PWP)

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean	Statement: Executive Summary and 5.4.4 Chronic Dietary Risk Assessment: "...most highly exposed population subgroup is children ages 1-2...42% of the cPAD."	5, 37	Comment: The text, while consistent with the select data presented in the summary table in 5.4.6, does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba. Acute and Chronic Dietary Exposure Assessments of Food and Drinking Water to Support the Use of Dicamba on Dicamba-Tolerant Cotton and Soybean for Amended Section 3 Registration, and Registration of the New N,N-Bis-(3-aminopropyl) methylamine (BAPMA) Salt Formulation	Statement: Executive Summary: "...most highly exposed...children ages 1-2...42% of the cPAD." VII. Results/Discussion: "...chronic...children 1-2 years old had the highest chronic dietary risk at 42% of the cPAD." IX. Conclusions: "...chronic...Children 1-2...42% cPAD."	2 9 10	Comment: The text, while consistent with the select data presented in summary Table 5 (p 10) does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-	Memorandum. Dicamba and Dicamba	Statements in 4.3 – 4.5 (including subsections)	20 - 28	Comment: There appear to be inconsistencies both

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
2016-0223-0002	BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean			within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. See Appendix 1 to this document for specific comments.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available”</i>	4	Comment: These studies have already been submitted. Freshwater (Fathead Minnow): Acute: MRID 48718008 ELS: MRID 48718010 Saltwater (Sheepshead Minnow) ELS: MRID 48718011

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
	Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species”</i></p>	4	<p>Comment: This study has already been submitted. MRID: 48718013</p>
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)</i></p> <p><i>Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.</i></p> <p><i>Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies “</i></p>	4	<p>Comment: A chronic study with worker bees has been reported in the published literature which could be used to evaluate the potential chronic effects Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. A bee brood study with dicamba is available from the published literature that could be used to evaluate potential chronic effects of dicamba on newly emerged honey bees. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental</p>

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				Entomology 1:611-614.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using dicamba’s metabolite, DCSA and the same species as used in the test with TGAI dicamba.”</i>	5	Question: Is the fish ELS study for DCSA required only for a freshwater species?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).”</i>	5	Comment: A residue decline study is available for dicamba on dicamba tolerant soybeans. The foliar dissipation of DCSA can be calculated from this study: “Determination of Dicamba Residue Decline in Forage after Application to Dicamba-Tolerant Soybean MON 87708 × MON 89788” MSL0022493. Also, there is foliar dissipation information for dicamba and DCSA in the magnitude of the residue study for dicamba tolerant soybeans: “Magnitude of Residues of Dicamba in Soybean Raw Agricultural and Processed Commodities after Application to MON 87708. MRID 48219901
EPA-HQ-OPP-2016-	Problem Formulation for the Environmental	Data Needs: <i>“Any new formulations for which an Endangered Species Act effect determination must</i>	5	Comment: The request for a Terrestrial Plants Field Study (850.4300) is not discussed elsewhere

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0223-0004	Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<i>be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300)."</i>		in the Problem Formulation document. Please provide additional information regarding what type of study is being requested.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>"It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury."</i>	9-10	Comment: If EPA is referring to the literature references cited in Footnote 1 on Page 7 of "Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)", it is important to note that none of the studies identified by EPA quantified or assessed vapor drift in any way. All of the reviewed papers intentionally made direct applications of dicamba at low rates to simulate particle drift – not volatilization – in order to assess plant effects at known rates.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Statement: <i>"... no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this</i>	13	Correction: Chronic studies on fathead minnow, sheepshead minnow, Daphnia magna, and mysid shrimp have been submitted. See Comments above for Page 4.

Docket ID No.	Document Name	Text	Page	Comment/Data Needed
	Review of Dicamba	<i>uncertainty.”</i>		
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>“as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA.”</i>	14	Correction: Chronic studies on fathead minnow and <i>Daphnia magna</i> are available for dicamba. See Comments above for Page 4.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2: Freshwater fish; Chronic (Early Life-Stage); No Data	14	Addition: Fathead Minnow NOAEC = 9.7 mg a.e./L MRID 48718010
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 4: Freshwater invertebrates; Chronic; No Data	14	Addition: <i>Daphnia magna</i> NOAEC = 42 mg a.e./L MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 6 Estuarine/marine fish; Chronic (Early Life-Stage); No Data	14	Addition: Sheepshead Minnow NOAEC = 11 mg a.e./L MRID 48718011

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	Drinking Water Assessments in Support of the Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 1 of Page 15 Estuarine/marine invertebrates; Acute; Grass shrimp EC ₅₀ >100 mg a.e./L	15	Question: EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) has the following endpoint: Grass shrimp EC ₅₀ > 132 mg a.e./L Which is correct?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2 of Page 15: Estuarine/marine invertebrates; Chronic; No Data	15	Addition: Mysid shrimp NOAEC = 11 mg/L MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 7, Row 1: Dicamba dimethylamine salt Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 > 112.4 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 > 977 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-	Problem	Table Endpoint:	15	Question:

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HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 8, Row 1: Dicamba sodium salt Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 = 111.6 mg a.e./L		The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 507.2 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 8, Row 2: Dicamba sodium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 9.2 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr EC50 34.6 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 10, Row 1: Dicamba potassium salt Bluegill Sunfish <i>Lepomis macrochirus</i> 96-Hr LC50 = 73.2 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 196 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Table Endpoint: Table 10, Row 2: Dicamba potassium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 301 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr

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	Assessments in Support of the Registration Review of Dicamba			EC50 639.8 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 1, Line 5: No acute oral data is available for dicamba's toxicity to passerine birds	17	Comment: A study for a passerine species has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 2, Line 4: Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees.	17	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993). Published literature studies report testing dicamba in a bee brood study and a chronic study with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614.

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EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 1: Birds, Acute Oral	18	Comment: Please clarify which study and endpoint the MRID number 42918001 refers to.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 2 Birds, Acute Oral (passerine) No data		Comment: An acute oral study for a passerine species is available with an endpoint LC50 > 213 mg a.e./kg bw. MRID 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 3 Subacute dietary: TGAI/TEP – 86.8%	18	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) indicates that the TGAI/TAP % ai is 86.6%
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Study Classification: Table 12, Row 3 of Page 19 Terrestrial Invertebrate Acute Contact (adult): The study is classified Supplemental / Quantitative.	19	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) lists MRID 00036935 as Acceptable. Please provide an explanation

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	Assessments in Support of the Registration Review of Dicamba			for any change in classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 4 Terrestrial Invertebrate Acute Oral (adult)	19	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 1 Birds, Acute Oral: Mallard Duck <i>Anus Platyrrhynchos</i> 14-D LC50>282 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >2452 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 2 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrrhynchos</i> 8-D LC50>2185 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4533 mg a.e./kg.
EPA-HQ-OPP-	Problem Formulation for the	Endpoint: Table 14, Row 1 Birds, Sub-acute dietary:	20	Comment: Has there inadvertently been a double correction

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2016-0223-0004	Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Bobwhite quail <i>Colinus virginianus</i> and 8-D LC50>2409 mg a.e./kg-bw		for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >9090 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 15, Row 1 of Page 21 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i> 8-D LC50>609 mg a.e./kg-bw	21	Correction: There has inadvertently been a double correction for acid equivalent content of the test substance. The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >1522 mg a.e./kg. This is consistent with an a.e. correction in the Science Chapter since the test substance was tested at 5620 ppm.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 16, Row 1 on Page 21 Birds, Acute Oral: Bobwhite quail <i>Colinus virginianus</i> 14-D LC50 = 235 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as 618 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Endpoint: Table 16, Row 1 on Page 22 Birds, Subacute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i>	22	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter

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	Assessments in Support of the Registration Review of Dicamba	8-D LC50>1822 mg a.e./kg-bw		for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4794 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 17, Row 2 Chronic (2-Generation Reproduction: Laboratory rat <i>Rattus norvegicus</i> NOAEL = 8 mg a.e./kg-diet/day LOAEL = 78 mg a.e./kg diet/day Endpoints: decreased pup weights	22	Comment: EPA's detailed analysis is not available to Monsanto; however, in general BMDL ₅ is a better, more refined estimate to use as a basis (point of departure) for the chronic risk assessment. In this case, 34.9 mg a.e./kg/day is the most appropriate value to use for the chronic risk assessment.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Study Classification: Table 19, Row 6 Aerobic Aquatic Metabolism: MRID 43758509 is listed as Supplemental	28	Comment: The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) classified this study as Acceptable. Please provide an explanation for the change in study classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 19, Row 5 of Page 29 MRID 49067704 is indicated to be a Field Volatility Study		Correction: MRID 49067704 is a field dissipation study
EPA-	Problem	Study Classification:	30	Comment:

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HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 20, Row 14, Page 30 Freshwater fish; Acute: MRID 00258932 is classified as Supplemental / Quantitative		MRID 258932 is classified as Supplemental / Qualitative in the EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 16, Page 30: Fresh invertebrates life cycle: No data	30	Comment: A <i>Daphnia</i> lifecycle study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 1, Page 31: Saltwater invertebrates life cycle: No data	31	Comment: A mysid lifecycle study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the	Data Needed: Table 20, Row 2, Page 31: Freshwater fish early-life stage: No data	31	Comment: A fathead minnow early-life stage study has already been submitted. MRID 48718010

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	Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 4, Page 31: Saltwater fish early-life stage: No data	31	Comment: A sheepshead minnow early-life stage study has already been submitted. MRID 48718011
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 32: Avian oral toxicity: No data on a passerine species	32	Comment: A passerine acute oral toxicity study has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 33: Honey bee adult acute oral toxicity (Tier 1): No Data	33	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-	Problem Formulation for the Environmental Fate, Ecological	Data Needed: Table 21 Honey bee adult chronic and larval acute and chronic testing: No Data	33-35	Comment: Published literature studies report testing dicamba in a bee brood study and a chronic study

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0004	Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba			with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614. These data could be used to evaluate whether chronic exposure to dicamba has any effects on honey bees.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 21, Last Row, Page 36 Vegetative Vigor: MRID 47814102	36	Correction: The MRID number should be 47815102
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Table A1.	38	Comment: Many of the rates given in this table do not seem to reflect the use rate limitations required in the 2009 Registration Eligibility Decision. Single Application Maximum – 1 lb a.e./A. Annual Application

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	Review of Dicamba			Maximum – 2 lb a.e./A.

`Appendix 1 to Monsanto Comments on Dicamba Registration Review Documents

EPA's Human Health Risk Assessment (HHRA) demonstrates that there is a reasonable certainty of no harm to the general public, including infants and children, from the proposed new uses of dicamba on dicamba-tolerant soybean and cotton.¹ However, EPA's decision to establish a chronic reference dose (cRfD) for dicamba of 0.04 mg/kg/day based on a Point of Departure (POD) of 4 mg/kg/day determined from the 2-generation rat reproduction study with the DCSA metabolite is extremely conservative and appears to lead to inconsistencies both within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. This decision is also inconsistent with (i.e., more conservative than) the conclusions of the Joint FAO/WHO Meeting on Pesticide Residues (JMPR).

Section 5.1.4 of the HHRA states, "Based on available toxicity studies and structural similarities, HED considers the parent and all three metabolites [DCSA, DCGA and 5-OH dicamba] to be of comparable toxicity." This is similar to the JMPR (2010) conclusion that "DCSA and DCGA have toxicity similar to or lower than that of dicamba" while 5-OH dicamba "appears to be of lower toxicity than the parent." In contrast, Section 4.3 of the HHRA indicates that DCSA is approximately 12-fold more toxic to offspring than dicamba acid. The latter statement is apparently based on the most recent EPA conclusions regarding the multi-generation rat reproduction studies with both compounds that were conducted at different times in different laboratories. Although full details are not available, this conclusion appears to be based, at least in part, on different Agency approaches used in evaluating or re-evaluating pup weights. Slight decreases in pup weight or pup weight gain relative to concurrent control were apparently reported in only one generation of both studies at 500 ppm. For DCSA, F1 pup weights at 500 ppm were lower than the concurrent control but were similar to those observed in the F2 controls as well as the laboratory's historical control values and were thus not considered to be a treatment related adverse effect. Although JMPR agreed with this conclusion, EPA concluded that 500 ppm was a Lowest Observed Adverse Effect Level (LOAEL). This resulted in a No Observable Adverse Effect Level (NOAEL) of 50 ppm, the next lowest concentration tested. In contrast, for dicamba, EPA apparently recently concluded that the decreased pup weights reported in one generation at both 500 and 1500 ppm were not treatment related due to the values being comparable to historical control data. EPA thus raised the dicamba offspring NOAEL from 500 ppm to 1500 ppm. It is not clear why comparisons to historical control data were acceptable for dicamba but not for DCSA. However, the end result is that although both the DCSA and dicamba studies appear to have similar marginal responses at 500 ppm, EPA conclusions regarding offspring NOAELs for these molecules are now quite different, 50 ppm and 1500 ppm, respectively. This does not appear to be consistent with the EPA conclusion that the two molecules exhibit comparable toxicity.

The EPA decision to reduce the chronic reference dose (cRfD) for dicamba from 0.45 to 0.04 mg/kg/day and to use this value for dietary risk assessment also does not appear to be justified. DCSA is only a very minor metabolite in conventional crops. Accordingly, the primary source for DCSA in the diet from the proposed uses will be from use of dicamba on dicamba-tolerant soybean (cotton consumption is negligible). However, based on the EPA analysis, potential residues in soybean represent only a very small percentage of the total dietary intake of dicamba. As a result, the vast majority of dietary exposure will be to parent dicamba, not DCSA.

¹ M1768 and M1769 herbicides would also be covered under the current HHRA for dicamba.

Therefore, it would seem more appropriate to assess the risks from these residues utilizing a cRfD based on dicamba data rather than an 11-fold lower cRfD based on a marginal response seen in a DCSA study.

The cRfD of 0.04 mg/kg/day proposed by EPA for use in dietary risk assessment is much lower than the value recommended by JMPR. JMPR concluded that the NOAEL for both the dicamba and DCSA rat reproduction studies was 500 ppm (~35 mg/kg/day for dicamba and ~37 mg/kg/day for DCSA). JMPR then concluded that an Acceptable Daily Intake (ADI) of 0.3 mg/kg/day was appropriate to characterize potential risks to both dicamba and its metabolites. This value was based on the NOAELs from the rabbit teratology and rat reproduction studies with dicamba and a 100-fold uncertainty factor.

Finally, the use of a Point of Departure (POD) of 4 mg/kg/day from the DCSA rat reproduction study for determining the cRfD for dicamba seems inconsistent with information included in the Second Addendum to the Environmental Fate and Ecological Risk Assessment (March 24, 2016). According to that document, EPA has conducted a benchmark dose analysis of the DCSA reproduction study and concluded that the threshold value for the NOAEL would be 8 mg/kg/day and that the lower 95% confidence limit on the benchmark dose resulting in a 5% change from background (BMDL₅) would be 34.9 mg/kg/day. It is not clear why these analyses were not summarized and utilized in the selection of the POD and cRfD in the HHRA.

TOXIC CONCOCTIONS

HOW THE EPA IGNORES THE DANGERS OF PESTICIDE COCKTAILS.



BY NATHAN DONLEY, PH. D.

CENTER FOR BIOLOGICAL DIVERSITY

JULY 2016

Executive Summary

More than 1 billion pounds of pesticides are used in the United States each year, applied to agricultural fields and orchards, residential lawns, playgrounds and parks. Pesticides are often mixed with other pesticides and chemicals before application or after, and the individual ingredients in these mixtures can interact in such a way as to enhance their toxic effects. **This is referred to as “synergy,” and it can turn what would normally be considered a safe level of exposure to people, wildlife and the environment into one that causes considerable harm.**

Although pesticide mixtures in the environment have been extensively documented, the Environmental Protection Agency generally only assesses the toxicity of pesticides individually, in isolation from potential real-life scenarios where these pesticides may interact with other chemicals. The EPA, which is tasked with ensuring that pesticides do not result in unreasonable harm to human health and the environment, often rationalizes this approach by stating that studies measuring mixture toxicity are often not available for analysis.

Our analysis, however, contradicts that claim by utilizing a publicly available information source (data from the U.S. Patent and Trademark Office) that provides a disturbing snapshot of pesticide synergy and the potential for widespread danger to people, waterways and wildlife — risks the EPA has repeatedly failed to identify and consider during its approval process.

For this report we conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta).

Among our key findings:

- 69 percent of these products (96 out of 140) had at least one patent application that claimed or demonstrated synergy between the active ingredients in the product;
- 72 percent of the patent applications that claimed or demonstrated synergy involved some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, among others, indicating that potential impacts could be widespread.

This suggests that synergistic action between pesticide active ingredients is much better documented and more common than current EPA pesticide assessments would indicate. Further, it appears that pesticide companies are in fact collecting information about the synergistic effects of their products that they are not sharing with the EPA. Recognizing that pesticide synergy data are widely available and that the synergistic relationships between pesticides can have serious implications for human and environmental health, the EPA must now take action to properly consider the potential consequences of pesticide synergy.

Introduction

Pesticide Registration

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), before a pesticide can be sold or distributed in the United States it must be registered — that is, approved — by the EPA. By law the EPA can only register a pesticide if its use will not cause unreasonable adverse effects on the environment.¹ To analyze whether any possible adverse effects may occur, the agency requires that toxicity studies be submitted to it by the chemical companies that plan to sell the pesticide (subsequently referred to as “pesticide registrants”). These studies typically analyze the relative toxicities of the pesticide to different taxa of plants and animals.² Once these data are analyzed, the EPA conducts a cost-benefit analysis that weighs the environmental costs with the purported economic benefits of pesticide use and decides whether or not to register a given pesticide.

The data that are required to be submitted by pesticide registrants almost always involve the use of a single pesticide in the absence of any other added chemicals. In reality pesticide exposures never occur in isolation. Pesticides are typically sold as formulations, meaning the pesticide is mixed with other chemicals in the bottle. These other chemicals can be other pesticides or “inert” ingredients, which are chemical additives that can affect the toxicity or absorption of the pesticide.³ In addition, pesticide products are often mixed in the field before application with other ingredients called “adjuvants”⁴ and/or other pesticide products. Pesticides that are applied on different geographic areas can also migrate away from the site of application and mix together in the environment.⁵ The EPA toxicity data requirements from chemical companies that focus on a single ingredient, combined with the fact that government and academic researchers often don’t have the means to study the vast landscape of mixture toxicity in sufficient detail, leads to an enormous gap in our knowledge of pesticide mixture toxicity.

Chemical Interactions

When chemicals mix in the environment, one of two things can happen: 1) the chemicals can interact in such a way as to change their toxicity profiles or 2) no interaction occurs. When chemicals do not interact, this is generally referred to as “additivity,” which means that no chemical in the mixture influences the toxicity of the other chemical(s) and toxicity can be estimated by how the chemicals act on their own. Alternatively, chemicals can interact to increase or decrease toxicity beyond the sum of the individual effects, which is referred to as “synergism” or “antagonism,” respectively.⁶ Synergism is particularly worrisome from a regulatory point of view, because, if it is not properly taken into account, adverse effects on human health or the environment can be much greater than originally estimated.

The EPA’s current guidance on how to assess mixture toxicity to humans directs the agency to assume that no interaction is occurring as a default unless available data indicate otherwise.⁷ In practice, because of the enormous data gaps on mixture toxicity, the EPA almost exclusively ends up assuming “no interaction” when the agency analyzes mixture toxicity to humans. There is currently no guidance on how the EPA assesses mixture toxicity to plants and animals other than humans, and the ecological risk assessment process does not generally assess pesticide mixture toxicity.⁶

Patent Applications

The extensive gaps in our knowledge of mixture toxicity ultimately weaken the EPA’s ability to effectively regulate pesticides, and new sources of data need to be identified. One new source of data was recently brought to the forefront with EPA’s approval of Enlist Duo, a new pesticide product from Dow that combines glyphosate and 2,4-D into one formulation for use on second generation genetically engineered crops. Following its registration of Enlist Duo, in preparing to defend itself in subsequent litigation on the registration

decision, the EPA came across a patent application from Dow that indicated glyphosate and 2,4-D result in synergistic toxicity to plants. This meant that the EPA's evaluation of the product at the registration phase lacked a full consideration of impacts to nontarget plants, including endangered species. The discovery of this patent application spurred the EPA to further request any relevant data from Dow about possible synergies and ultimately ask a court to vacate its decision to register Enlist Duo.⁸

When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office (USPTO) has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant.⁹ For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

In the case of Enlist Duo, the fact that publicly available data from a patent application was unknown to the EPA until it was working to defend itself in litigation highlights just how broken this process is. Enormous data gaps, coupled with nonconservative measures of mixture toxicity, have created a precarious framework of assumptions that, in many cases, underestimates the toxicity of pesticide mixtures to humans and the environment.

Analysis

Pesticide Products

For this analysis we sought to understand just how extensive the patent landscape was regarding claims of pesticide synergy. To ensure that our analysis was relevant to pesticide mixtures that were going to be encountered in the environment, we limited it to products that

contain multiple pesticide ingredients (subsequently referred to as "active ingredients"). Specifically, we identified all of the products from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta — hereafter referred to as "The Big Four") the EPA approved in the past six years that contained two or more active ingredients.¹⁰ This way we identified pesticides that were absolutely certain to be co-applied because they are sold together in a single product. A more detailed description of our methodology is outlined in Appendix A.

We found 140 products from The Big Four, approved between June 2010 and June 2016, that contained at least two active ingredients. Each product contained anywhere from two to six active ingredients, and all were characterized as an herbicide, insecticide or fungicide/nematicide. The largest group of multi-ingredient products from The Big Four that have been approved in the past six years was herbicides, accounting for 67 of the 140 products. A breakdown of the products by company indicates that Bayer, Dow, Monsanto and Syngenta had 49, 26, 5 and 60 products that were included in our analysis, respectively.

Synergy Patents

We then searched various databases for patent applications that made a claim of synergy for at least two of the active ingredients in the product (methodology outlined in Appendix A). Only patent applications submitted to the USPTO were included in this analysis; patent applications in other countries were excluded. All patent applications that were granted, denied or still in the application process were included in our analysis because the status of the application has no bearing on the underlying accuracy of the synergy claims. The USPTO generally does not pass judgment on whether synergy exists or not; it takes applicants at their word, only considering whether the claims are nonobvious and therefore patentable.

Remarkably, of the 140 pesticide products included in our analysis that contain multiple active ingredients, 96 had at least one patent

application that claimed or demonstrated synergy between the active ingredients in the product, a total of 69 percent (Figure 1a and Appendix B). These 96 products had at least one patent application and as many as six, claiming or demonstrating synergy between the active ingredients in the product. The majority of patent applications contained experimental data that were included in the application as evidence of the claimed synergy. For all patent applications, synergy was claimed or demonstrated for target organisms (i.e. synergistic toxicity to target insect species for insecticidal ingredients). A breakdown of the patent synergy claims by company indicates that 71 percent (35/49), 46 percent (12/26), 40 percent (2/5) and 78 percent (47/60) of Bayer, Dow, Monsanto and Syngenta products had patent applications that claimed synergy between at least two of the active ingredients in the product, respectively.

As some of the approved products contained similar ingredients, many patent applications covered multiple products. There were a total of 47 patent applications that covered the ingredient mixtures in the products included in our analysis.¹¹ Many of the ingredients covered by

these patent applications are very widely used, with 72 percent (34/47) of patent applications involving high use ingredients (more than 1 million pounds used per year in the U.S. agricultural sector) (Figure 1b).¹²

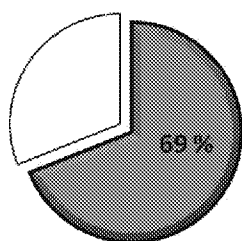
Acuron, a case study

In 2015 the EPA conditionally registered a pesticide product from Syngenta called Acuron (EPA Reg. No. 100-1466, Decision No. 470872). Acuron combines four different active ingredients — bicyclopyrone, S-metolachlor, mesotrione and atrazine — into a single formulation to control weeds in cornfields. The approval of the Acuron product was combined with the approval of the new active ingredient bicyclopyrone, and therefore went through public review and comment.¹³

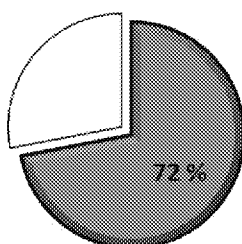
In response to the Center for Biological Diversity's public comments regarding possible synergistic effects of Acuron, the EPA stated: "Concerning synergistic effects, the agency does not routinely include a separate evaluation of mixtures of active ingredients. However, there are some data available to the agency regarding synergistic effects and EPA believes it adequately addressed the issue of synergism between bicyclopyrone and atrazine."¹⁴ But the EPA provides no information on how it addressed this issue of synergism as there is no mention of this analysis in the ecological risk assessment,¹⁵ no separate analysis was provided to the public, and there was no mention of whether synergy was analyzed for ingredient combinations other than bicyclopyrone and atrazine. The agency further indicated that a study of acute toxicity of Acuron to mammals was analyzed and did not indicate synergy was occurring.¹⁴ However, it did not analyze chronic toxicity to mammals or acute and chronic toxicity to all other taxa like birds, fish, invertebrates and plants as a result of Acuron exposure prior to approving this product.

As Acuron is a Syngenta product that was approved in the past six years, it was included in our patent analysis. We found three patent applications claiming synergistic toxicity to plants

Fig 1 A) Percentage of Recently Approved Multi-ingredient Products That Have Evidence of Synergy



B) Percentage of Identified Synergy Patents That Involve High Use Ingredients



from exposure to the ingredients in this product: the combination of 1) S-metolachlor and mesotrione (app # 12374219), 2) mesotrione and atrazine (app # 12675156) and 3) atrazine and S-metolachlor (app # 08930901) (Appendix B). Since bicyclopyrone has the same mode of action as mesotrione,¹⁶ it is likely that any synergy observed with mesotrione and other ingredients will be present with bicyclopyrone and those ingredients as well. Synergistic toxicity of mesotrione and atrazine to certain species of plants has also been extensively documented in the literature.^{17- 22} Finally, in publicly available promotional materials for Acuron, Syngenta has not only claimed that mesotrione and bicyclopyrone work synergistically with atrazine to kill plants, but they have mapped out the exact mechanism by which synergy occurs.²³

It is clear that there are at least three and as many as five layers of synergy that result from the combination of ingredients in Acuron (Figure 2). This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them. The EPA is charged with ensuring that pesticide use results in no unreasonable adverse effects to the environment or harm to endangered or threatened species. It is still unclear how the agency came to its conclusion for Acuron without properly considering this publicly available, relevant information.²⁴

Discussion

Our analysis indicates that there are patent applications claiming or demonstrating synergistic action for 69 percent of the recently approved products from The Big Four pesticide companies that contain multiple active ingredients. This percentage is very high and disconcerting. Synergy between chemicals is not generally thought to be a very common phenomenon, which is one reason regulatory agencies typically assume additivity. However, in the case of premixed products, this high percentage makes perfect sense. Combining synergistically acting chemicals into a single product not only allows a company to gain patent protection on the combination of ingredients in their product, but, from a product performance point of view, it makes sense to combine ingredients that will enhance each other's ability. Unfortunately enhancing toxicity to target organisms will often enhance toxicity to many nontarget organisms as well. Perhaps most worrisome is that 72 percent of the patent applications we identified claimed or demonstrated synergy with some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, indicating that potential impacts could be widespread.

We're also certain that 69 percent is an *underestimate* of how many of these products have synergistic activity. There are multiple reasons for this conclusion:

1. We only took into account U.S. patent applications. In our search we found multiple relevant patent applications filed with other countries as well as with the World Intellectual Property Organization (WIPO). For example, a U.S. patent application could not be identified for the product combining methoxyfenozide and spinetoram (EPA reg No. 62719-666), however Dow submitted a patent application

Fig 2

Synergy Evidence for Acuron (mesotrione, S-metolachlor, bicyclopyrone, atrazine)

Line of evidence	patent claim	published studies	promotional materials	based on mode of action
S-metolachlor + mesotrione	X			
mesotrione + atrazine	X	X	X	
S-metolachlor + atrazine	X			
bicyclopyrone + atrazine			X	X
bicyclopyrone + S-metolachlor				X

to the WIPO claiming that this active ingredient combination works synergistically to kill an insect target organism.²⁵

2. Many relevant patent applications may not be publicly available yet. The products that we analyzed were approved relatively recently, and it is therefore likely that some relevant patent applications were filed recently as well. The USPTO delays the publishing of patent applications for 18 months after the date of first filing.²⁶ So any patent applications filed within the past year and a half may not be publicly available and would not have been identified by our search strategy.
3. Because “inert” ingredients in pesticide products are not made available to the public, we were unable to search for patent applications that demonstrated synergy between the active ingredients and other ingredients contained in the pesticide product. We did come across many patent applications claiming synergy between the active ingredients in the analyzed products and commonly used “inert” ingredients;²⁷ however, the lack of ingredient transparency in pesticide products prohibited the inclusion of possibly relevant patent applications. Therefore, more layers of synergy may be present in these products than were identified in this analysis.
4. Searching for patent applications is surprisingly difficult. It is possible that our search strategy (Appendix A) missed relevant patent applications.
5. We only searched for claims of synergy in patent applications. As was the case with Acuron, some of these chemical combinations may have been demonstrated to act synergistically on target or nontarget organisms in peer-reviewed scientific studies. Any such study would not have been identified in our analysis. Furthermore, any unpublished, internal studies done by chemical companies would, of course, not be identified either.

Pesticide companies likely possess additional information regarding pesticide synergy that they do not include in their patent applications. Patent applications are very different from scientific studies, which are the typical data source used by the EPA to assess risk. The latter are very descriptive and data intensive, while the former provide the bare minimum of information required to demonstrate to the patent office that their claim is legitimate. This does not necessarily mean that experimental data provided in patent applications are somehow less scientifically valid than data from scientific studies, only that more data may be available from the patent applicant than was provided to the patent office. The EPA acknowledged this fact in the Enlist Duo case by not just relying on the information contained in the relevant patent application, but also requiring Dow to submit any relevant data on the synergy between glyphosate and 2,4-D that was in its possession.⁸ In many cases the patent applicant will have additional data on synergism in their possession, as extensive experimentation is typically done before a company will invest the time and money to develop a product that they intend to market. It is important that this be kept in mind when scientifically evaluating the data contained in patent applications.

We cannot say with absolute certainty that the patent data on synergy that we identified were not used in making registration decisions for these products. There are multiple reasons for this. The first is that, unlike Acuron, many individual products are given approval without public review and comment, so the analysis that went into the product approval, if any, is not shared with the public. Second, even when products do go through public review and comment, a mixture toxicity analysis is either not performed or not outlined in sufficient detail for the public to understand all of the lines of evidence that were used. However, given that, in the case of Enlist Duo, the EPA indicated that it just recently became aware that patent data on synergy exist and the fact that it is not common practice to do a mixture analysis for the ecological risk assessment, we think it is extremely likely

that most, if not all, of these product approvals were made without taking into account this relevant patent information.

It is also unclear why the EPA has not previously been made aware of these patent data by pesticide registrants. Registrants are required to submit information to the EPA that could raise concerns about the continued registration of a product or about the appropriate terms and conditions of registration.²⁸ For example, pursuant to 40 CFR §159.195(a)(3), the registrant is required to submit information that indicates “[u]se of a pesticide may pose any greater risk than previously believed or reported to the Agency.” Data on chemical synergy would certainly fall into that category. It appears that chemical companies are using synergy to demonstrate that chemical combinations have some sort of novelty associated with them and are, therefore, patentable — yet when it comes to the toxicities associated with this synergy, this information never makes it to the EPA.

Recommendations

Searching for patent applications can be a difficult process that takes considerable time and knowledge. Often the pesticide is not referred to by its common name in the patent application, making a simple keyword search insufficient to identify all relevant patent information. The EPA cannot rely on stakeholders to provide all of the necessary information from patent applications, but rather the EPA must place the burden to produce and submit information related to synergistic effects squarely where it belongs: on the pesticide registrant or applicant.

1. Registrants or applicants need to be made aware that failure to submit relevant data to the EPA will be a violation of their duties under Section 6(a)(2) of FIFRA.²⁹ When applicable, enforcement should be pursued when registrants fail to provide those data.
2. To identify patent data that are not affiliated with the pesticide registrant, the EPA needs to use a stepwise approach of

doing a keyword and structure search for patent applications concerning the pesticide of interest followed by a rigorous analysis of the claims in the patent application.

3. Any claims of synergy need to be assessed for relevance given the label restrictions for the pesticide (or lack thereof) and the inert ingredients that are present in any formulation up for approval.
4. Appropriate measures need to be taken to ensure that any registration decision is compliant with FIFRA. This may include label restrictions on mixing, increased in-field buffers, lower application rates or even product cancellation.

A full analysis of mixture toxicity needs to be taken into account for both the human health and ecological risk assessments. When patent applications or other data demonstrate synergistic toxicity to target organisms, that synergy needs to be assumed for all other nontarget organisms within that taxon. For instance if a mixture results in synergistic toxicity to a target insect, like an aphid, then that synergy needs to be assumed for all insects and possibly all other invertebrates in the ecological risk assessment unless available data indicate otherwise. This would be consistent with EPA’s current use of surrogate species to estimate toxicity to other species within the same taxon for the human health and ecological risk assessments. This is one way that the EPA can begin to take into account mixture toxicity given the extensive data gaps that are currently present.

Conclusions

The human health and ecological risk assessments are a key part of the EPA’s pesticide-approval process; without them the agency cannot justifiably conclude that a pesticide can be used without unreasonable harm. When relevant data are not included in the risk assessment, and nonconservative assumptions are made about mixture toxicity, it diminishes the process and ultimately underestimates harm to humans and the environment.

The patent applications identified in this analysis are just the tip of the iceberg. The patent landscape on pesticide mixtures is vast and in no way limited to pesticides that are sold together in formulations. In fact, the implications of this analysis should extend far beyond that of multi-ingredient product approval. The entire pesticide-approval process is designed to narrowly assess the toxicity of individual active ingredients one at a time; yet when most of these active ingredients are being routinely co-applied on agricultural fields across the country, the initial analyses that were done are no longer relevant to real-world

exposure scenarios and are not an appropriate estimate of true risk.

This analysis highlights the shortcomings of such a narrow approach. Since mixture toxicity is such a low priority for the EPA, it is no surprise that relevant information was missed for so long. Clearly pesticide synergy is not a rare occurrence and should no longer be treated as such. The EPA must take into account relevant patent data and other lines of evidence and fundamentally alter its approach to assessing pesticide mixtures.

Appendix A

Methodology of Product Search

We used the EPA's Pesticide Product Label System database to conduct our search.³⁰ In the "company name" search box we searched for "Bayer," "Dow Agrosiences LLC," "Monsanto Company" and "Syngenta Crop Protection," which identified 685, 369, 176 and 539 products respectively. These are all of the pesticide products with "active" status for these four companies as of June 23, 2016 (a total of 1769). To identify the products that had their initial approval in the last six years *and* had multiple active ingredients, we found all active products that had a date on or after June 23, 2010 in the "current status" column. We then searched the pesticide labels of each of those products. If the label indicated two or more active ingredients were present in the product, it was included in our analysis. Of the 1769 active products for these companies, 140 had multiple active ingredients and were first approved by the EPA in the past six years. All of these products are listed in Appendix B.

Methodology of Patent Search

To identify all applicable patent applications, we used a multi-layered search strategy. First, we used the search engines from Google Patents,³¹ FreePatentsOnline³² and the USPTO³³ to do simple keyword searches. The common names of each pesticide were searched concomitantly with the words "synergy," "synergistic" or "synergism." We found many relevant patents using this strategy, but quickly became aware of the limitations of doing a simple keyword search. Many patent applicants do not refer to pesticides by their common name but instead use a common core structure along with various possible side groups to describe the chemicals they want to patent. In order to identify these patents, we used a search engine called SureChEMBL.³⁴ This allows the user to search patent applications for the chemical structure of the pesticide in conjunction with keywords. In addition, we used SciFinder³⁵ to search patent applications by the pesticide's Chemical Abstracts Service (CAS) number and filtered results by other pesticides mentioned in the patent or by the word "synergistic."

All of the patents we identified were further scrutinized. First, any patent application that was not

submitted to the USPTO was discarded. This is because many of the patent applications submitted to other countries that we identified were in a language other than English; however, we note that this discarded information could likely be useful to the EPA. We then went through each of the identified patents and verified that claims of synergy were made for at least two of the active ingredients in the product. If it was stated anywhere in the patent application that a mixture of chemicals acted synergistically to produce toxicities to any organism, that patent was used in our analysis. However, we note that a strong majority of patent applications also contained experimental evidence of synergy.

Notes were taken on each patent included in our analysis, including:

- 1) The company that was listed as the applicant or assignee of the patent application and whether this was different from the registrant of the product.
- 2) The taxa of the organism(s) for which synergy was claimed (plants, insects, fungi, nematodes).
- 3) If there was a possible difference in stereoisomer content of the chemicals in the pesticide product and the patent application. Since lambda-cyhalothrin is a mixture of enantiomers, one of which is gamma-cyhalothrin, any claims of synergy for one was assumed for the other. Similarly, since mefenoxam is one of the two enantiomers that are present in metalaxyl, any claims of synergy for one was assumed for the other.
- 4) If any experimental evidence of synergy was provided in the patent application as well as the magnitude of the synergy as measured by the Colby equation.³⁶ If experimental data were provided in the application and a Colby analysis was performed, the extent of synergy (low, medium and high) was noted for each patent application. The observed response (C_{obs}) and the expected response (assuming no interaction) (C_{exp}) were used to make this determination. If the difference of C_{obs} and C_{exp} was less than 10, that was considered low synergy. If the difference of C_{obs} and C_{exp} was between 10 and 20, that was considered medium synergy. And if the difference of C_{obs} and C_{exp} was greater than 20 or if C_{obs}/C_{exp} was greater than 2, then that was considered high synergy. Also, if experiments were performed but no data were provided, or if experimental data were given but no Colby equation was done, we took note of that as well (Appendix B).

Appendix B

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
7/14/2010	D	62719-616	penoxsulam; cyhalofop												
7/20/2010	S	100-1369	thiamethoxam; fludioxonil; azoxystrobin; mefenoxam	10496187	3	F	S	10170902	1, 7	F	S				
7/25/2010	B	72155-90	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
7/26/2010	B	72155-91	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
7/26/2010	B	72155-89	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
8/2/2010	B	264-1103	lodosulfuron-methyl-sodium; mesosulfuron-methyl												
8/3/2010	D	62719-617	aminopyralid; metsulfuron methyl	12945099	6	P	D								
8/5/2010	S	100-1366	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/5/2010	S	100-1367	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/6/2010	D	62719-612	penoxsulam; isoxaben												
9/3/2010	S	100-1352	fludioxonil; mefenoxam; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S				
10/14/2010	B	432-1513	trifloxystrobin; triadimefon												
10/29/2010	S	100-1384	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
11/24/2010	S	100-1385	fomesafen; glyphosate												
1/20/2011	B	352-846	aminocyclopyrachlor; chlorsulfuron												
1/20/2011	B	352-848	aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
1/20/2011	B	352-847	imazapyr; aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
2/16/2011	S	100-1389	pinoxaden; fluroxypyr												
3/2/2011	S	100-1396	fomesafen; glyphosate												
3/10/2011	D	62719-630	2,4-D; aminopyralid	13014909	6	P	D								
3/10/2011	D	62719-628	2,4-D; aminopyralid	13014909	6	P	D								
3/11/2011	S	100-1377	azoxystrobin; propiconazole												
3/11/2011	S	100-1378	azoxystrobin; propiconazole												
3/24/2011	S	100-1393	fludioxonil; mefenoxam	8799310	1, 3	F	S								
4/10/2011	D	62719-629	2,4-D; aminopyralid	13014909	6	P	D								
4/12/2011	S	100-1364	chlorothalonil; acibenzolar-S-methyl												
4/12/2011	B	72155-98	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-99	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-100	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-101	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/26/2011	B	72155-104	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
4/29/2011	B	264-1132	clothianidin; Bacillus-firmus I-1582	12936700	3	I, F, N	B								
5/2/2011	B	72155-102	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/2/2011	B	72155-103	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/5/2011	D	62719-637	triclopyr; fluroxypyr												
6/3/2011	S	100-1402	<i>lambda</i> -cyhalothrin; chlorantraniliprole												
6/13/2011	B	72155-105	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
6/15/2011	S	100-1399	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
				14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
6/27/2011	D	62719-640	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
8/12/2011	B	72155-106	2,4-D; isoxaben; mecoprop-p; dicamba	13841457	6	P	B								
8/17/2011	B	264-1134	lodosulfuron-methyl sodium; thien carbazon-methyl	12824951	6	P	B								

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/19/2011	S	100-1405	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
11/16/2011	S	100-1410	S-metolachlor; mesotrione	14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
12/6/2011	B	264-1135	thiencarbazone-methyl; pyrasulfotole; bromoxynil	12374219	6	P	S								
12/14/2011	S	100-1414	S-metolachlor; mesotrione; atrazine	12824951	4	P	B								
1/11/2012	S	100-1415	azoxystrobin; thiamethoxam	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
1/26/2012	B	432-1519	thiencarbazone-methyl; foramsulfuron; halosulfuron-methyl												
2/1/2012	S	100-1433	azoxystrobin; difenoconazole	13902364	5	P	B	12824951	5	P	B				
2/2/2012	S	100-1427	thiamethoxam; mefenoxam; fludioxonil	10496185	8	F	S								
2/2/2012	S	100-1426	thiamethoxam; mefenoxam; fludioxonil; thiabendazole	13209926	2, 3	F	Bf	8799310	1, 3	F	S				
2/2/2012	B	264-1091	fluopyram; tebuconazole	11563240	6	F, N	S	8799310	1, 3	F	S				
2/2/2012	B	264-1090	fluopyram; trifloxystrobin												
2/2/2012	B	264-1085	fluopyram; pyrimethanil												
2/2/2012	B	264-1084	fluopyram; prothioconazole												
2/7/2012	D	62719-646	acetochlor; atrazine												
2/14/2012	S	100-1429	pinoxaden; fenoxaprop-p-ethyl												
2/15/2012	D	62719-645	clpyralid; aminopyralid	13715230	6	P	D	14102818	6	P	D				
2/22/2012	S	100-1428	difenoconazole; mefenoxam												
4/23/2012	S	100-1436	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/23/2012	S	100-1437	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/27/2012	B	72155-107	metsulfuron-methyl; thiencarbazone-methyl; indaziflam; dicamba	12824951	6	P	B	12506456	3	P	B				
4/30/2012	S	100-1438	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
5/11/2012	B	264-1125	penflufen; clothianidin	11912773	6	I	B								
5/11/2012	B	264-1123	penflufen; prothioconazole	13061976	3	F	B								
5/11/2012	B	264-1122	prothioconazole; penflufen; metalaxyl	10508208	2, 3	F	Bf	12663273	5	F	B				
5/11/2012	B	264-1124	penflufen; trifloxystrobin	12663273	4	F	B								
5/11/2012	B	164-1121	clothianidin; penflufen; trifloxystrobin; metalaxyl	11793763	6	I	B	10486663	6	I	B	12663273	5	F	B
				13209926	2, 3	F	Bf	11912773	6	I	B				
6/20/2012	S	100-1383	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
6/21/2012	S	100-1440	abamectin; thiamethoxam	11028776	7	I	S								
8/2/2012	S	100-1442	S-metolachlor; mesotrione; atrazine	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
8/23/2012	S	100-1449	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
10/31/2012	S	100-1441	chlorothalonil; difenoconazole	12066894	8	F	S								
12/6/2012	S	100-1455	mesotrione; proflumicarb	12374195	6	P	S								
1/15/2013	M	71995-57	glyphosate; diquat dibromide												
1/15/2013	M	71995-56	glyphosate; diquat dibromide												
1/15/2013	S	100-1457	abamectin; thiamethoxam; mefenoxam; fludioxonil	11028776	7	I	S	8799310	1, 3	F	S				
1/22/2013	B	432-1528	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
1/23/2013	S	100-1458	<i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
1/30/2013	S	100-1459	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
1/30/2013	S	100-1460	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
3/5/2013	D	62719-655	2,4-D; picloram												
3/7/2013	D	62719-653	2,4-D; picloram												
4/2/2013	D	62719-673	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
4/3/2013	D	62719-671	atrazine; acetochlor												
4/4/2013	D	62719-668	atrazine; acetochlor												
4/4/2013	D	62719-670	atrazine; acetochlor												
6/11/2013	B	432-1527	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
6/12/2013	S	100-1444	thiamethoxam; fludioxonil; difenoconazole	7792845	4	F	S								
6/17/2013	S	100-1470	glyphosate; mesotrione												
6/19/2013	B	72155-110	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
7/22/2013	D	62719-666	methoxyfenozide; spinetoram												
8/8/2013	B	352-845	aminocyclopyrachlor; sulfometuron-methyl; chlorsulfuron												
8/29/2013	D	62719-667	methoxyfenozide; spinosad												
2/3/2014	D	62719-648	cyhalofop; fluroxypyr	12913235	6	P	D								
2/6/2014	S	100-1421	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1422	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1424	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/27/2014	D	62719-679	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	M	524-614	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	S	100-1508	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
4/22/2014	M	524-616	dicamba; glyphosate	13099552	2, 6	P	D	13751021	7	P	M				
5/16/2014	D	62719-680	sulfentrazone; cloransulam-methyl												
5/29/2014	S	100-1527	thiamethoxam; difenoconazole; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				7792845	4	F	S	12278731	6	F	S				
5/30/2014	S	100-1526	difenoconazole; mefenoxam; fludioxonil; sedaxane	8799310	1, 3	F	S	7792845	4	F	S	12278731	6	F	S
6/10/2014	B	264-1168	fenoxaprop-p-ethyl; pyrasulfotole; bromoxynil octanoate; bromoxynil heptanoate												
7/16/2014	S	100-1540	propiconazole; azoxystrobin												
7/29/2014	B	432-1533	foramsulfuron; iodosulfuron-methyl; thiencazone-methyl	13902364	5	P	B	12824951	6	P	B				
9/29/2014	B	264-1170	spirotetramat; imidacloprid	13790375	7	I	B								
10/10/2014	S	100-1555	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
10/15/2014	D	62719-649	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
11/12/2014	B	432-1530	imidacloprid; spirotetramat	13790375	7	I	B								
12/2/2014	S	100-1530	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
12/22/2014	S	100-1549	azoxystrobin; propiconazole; <i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
12/23/2014	S	100-1550	azoxystrobin; acibenzolar-S-methyl												
1/12/2015	S	100-1506	azoxystrobin; difenoconazole	10496185	8	F	S								
1/14/2015	S	100-1554	azoxystrobin; difenoconazole	10496185	8	F	S								
2/6/2015	B	264-1171	imidacloprid; fluopyram												
4/13/2015	M	524-620	acetochlor; fomesafen												
4/21/2015	B	72155-112	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/21/2015	B	72155-113	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/24/2015	S	100-146	atrazine; bicyclopyrone; S-metolachlor; mesotrione	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
4/27/2015	D	62719-689	cloransulam-methyl; flumioxazin												
7/17/2015	B	72155-114	tau-fluvalinate; tebuconazole												
8/5/2015	S	100-1561	sedaxane; mefenoxam; fludioxonil	8799310	1, 3	F	S	12278731	6	F	S				
8/23/2015	S	100-1450	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
8/28/2015	D	62719-685	clopyralid; fluroxypyr; pyroxusulam												

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/8/2015	B	432-1544	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
10/19/2015	S	100-1556	thiamethoxam; fludioxonil; difenoconazole; sedaxane	12306870	2, 6	I	B	7792845	4	F	S	12278731	6	F	S
10/19/2015	S	100-1559	thiamethoxam; mefenoxam; thiabendazole; fludioxonil; sedaxane	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
11/10/2015	B	11556-186	diflubenzuron; permethrin												
12/9/2015	B	264-1182	penflufen; trifloxystrobin; metalaxyl	12663273	5	F	B								
1/6/2016	D	62719-693	acetochlor; mesotrione; clopyralid	12074809	3	P	D								
2/3/2016	S	100-1564	thiamethoxam; difenoconazole; mefenoxam; sedaxane; cytokinin; gibberellic acid; indole butyric acid	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
2/8/2016	S	100-1568	bicyclopyrone; mesotrione; S-metolachlor	12374219	6	P	S								
2/17/2016	B	264-1184	dicamba; tembotrione												
2/24/2016	D	62719-702	penoxsulam; oxyfluorfen	13014869	6	P	D								
4/11/2016	B	432-1583	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
4/12/2016	S	100-1563	thiamethoxam; thiabendazole; sedaxane; mefenoxam; fludioxonil	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
6/16/2016	S	100-1587	fludioxonil; sedaxane; thiamethoxam	12278731	3	F	S	12306870	2, 5	I	B				
6/20/2016	B	432-1537	fluopyram; trifloxystrobin												

Column 1: Date that the product was first approved by the EPA

Column 2: Registrant of the approved product (D=Dow, M=Monsanto, S=Syngenta, B=Bayer)

Column 3: Registration number of the product. Information on products can be found by searching the registration number on the EPA's Pesticide Product Label System found here:

<https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>

Column 4: A list of the active ingredients found in each product

Column 5: The patent application number. Patent applications can be searched by application number on USPTO's Public Pair Portal found here:

<http://portal.uspto.gov/pair/PublicPair>

Column 6: Notes taken on the patent. **For more detailed information see Appendix A**

1 = Stereoisomer content of a pesticide in the product may differ from that analyzed in the patent.

2 = Applicant/assignee of patent application differs from the registrant of the product

3 = No experimental evidence was provided in the patent application

4 = Experimental evidence was provided in the patent application, which indicated low synergy

5 = Experimental evidence was provided in the patent application, which indicated medium synergy

6 = Experimental evidence was provided in the patent application, which indicated high synergy

7 = Experimental evidence was provided in the patent application but no Colby equation was performed

8 = Experiments were said to be performed but data were not provided in the patent application

Column 7: Taxa for which synergistic toxicity is claimed or demonstrated (P=Plants, I=Insects, F=Fungi, N=Nematodes)

Column 8: Applicant/assignee of the patent (D=Dow, M=Monsanto, S=Syngenta, B=Bayer, Du=DuPont, Bf=BASF)

Columns 9-12: Repeat columns 5-8

Columns 13-16: Repeat columns 5-8

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- ¹ 7 U.S.C. § 136a(c)(5)(C), (D); 40 C.F.R. § 152.112(e).
- ² EPA. Pesticide Registration: Data Requirements for Pesticide Registration. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/data-requirements-pesticide-registration#nto>.
- ³ Cox, C., and Sorgan, M. (2006) Unidentified inert ingredients in pesticides: implications for human and environmental health. *Environ Health Perspect*, 114(12), 1803-1806.
- ⁴ EPA. Pesticide Registration: Pesticide Registration Manual: Chapter 1 - Overview of Requirements for Pesticide Registration and Registrant Obligations. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/pesticide-registration-manual-chapter-1-overview-requirements-pesticide#adjuvants>.
- ⁵ Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L., Scott, J.C., Stackelberg, P.E., Thelin, G.P., Wolock, D.M. (2006) Pesticides in the Nation's Streams and Ground Water, 1992-2001: U.S. Geological Survey Circular 1291. Available at: <http://pubs.usgs.gov/circ/2005/1291/>.
- ⁶ Lydy, M., Belden, J., Wheelock, C., Hammock, B., Denton, D. (2004) Challenges in regulating pesticide mixtures. *Ecology and Society* 9(6): 1. Available at: <http://www.ecologyandsociety.org/vol9/iss6/art1/>.
- ⁷ EPA. (2000) Supplementary guidance for conducting health risk assessment of chemical mixtures. EPA/630/R-00/002. Accessed 6/21/2016. Available at: <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=20533>.
- ⁸ Respondents' Motion for Voluntary Vacatur and Remand filed in *Natural Resources Defense Council, Inc. v. U.S. EPA*, No. 14-73353 (consolidated with 14-73359), ECF Dkt. No. 121 (filed November 24, 2015 9th Cir.).
- ⁹ 35 U.S.C § 103.
- ¹⁰ Instead of identifying all of the products that were approved in the last six years that have multiple active ingredients, we decided to focus our analysis on just four companies. Our reasoning is that the EPA's pesticide product label database is of limited utility. The only search terms are "product name," "company name" or "EPA registration number." The only way to identify all products approved by date is to search by company, so we focused our analysis on the major players in the agrichemical business.
- ¹¹ The 47 USPTO patent application numbers are: 13014909, 11028776, 12074809, 14172201, 12945099, 12675156, 8930901, 12066894, 9968175, 13715230, 14102818, 12936700, 11793763, 13209926, 10486663, 11628145, 12913235, 9968173, 12633063, 14215205, 13099552, 13751021, 10496185, 10170902, 10496187, 7792845, 12147853, 14567574, 12506456, 13841457, 8799310, 11028769, 11563240, 14183671, 12374195, 12374219, 11912773, 12663273, 13061976, 14026902, 13014869, 10508208, 12278731, 13790375, 12306870, 13902364 and 12824951.
- ¹² Usage information was collected from the USGS National Water-Quality Assessment (NAWQA) Program. Pesticide National Synthesis Project – annual pesticide use maps 2013. Available here: https://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php. High use ingredients (defined as more than one million pounds active ingredient used in the agricultural sector per year in the U.S.) covered by the identified patent applications include: 2,4-D, thiamethoxam, acetochlor, clopyralid, atrazine, mesotrione, S-metolachlor, chlorothalonil, imidacloprid, clothianidin, dicamba, glyphosate, azoxystrobin, bromoxynil.
- ¹³ EPA. Regulations.gov docket number EPA-HQ-OPP-2014-0355. Bicyclopyrone: New Proposed Tolerance in/on Corn commodities and a New Proposed Import Tolerance in/on Sugarcane. Available at: <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2014-0355>.
- ¹⁴ EPA. (2015) Bicyclopyrone: Response to Public Comments on EPA's "Proposed Registration of the New Active Ingredient Bicyclopyrone." Document ID: EPA-HQ-OPP-2014-0355-0076. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0076>.
- ¹⁵ EPA. Memorandum. (2015) Environmental Fate and Ecological Risk Assessment for Use of the New

Herbicide Bicyclopyrone (NOA449280). Document ID: EPA-HQ-OPP-2014-0355-0015. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0015>.

¹⁶ The United Soybean Board. Take Action. Herbicide Classification Chart. Accessed 6/22/2106. Available at: <http://takeactiononweeds.com/wp-content/uploads/herbicide-classification-chart-2016.pdf>.

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¹⁸ Woodyard, A., Bollero, G., Riechers, D. (2009) Broadleaf Weed Management in Corn Utilizing Synergistic Postemergence Herbicide Combinations. *Weed Technology*, 23(4), 513-518.

¹⁹ Sutton, P., Richards, C., Buren, L., Glasgow, L. (2002) Activity of mesotrione on resistant weeds in maize. *Pest Manag Sci*, 58(9), 981-984.

²⁰ Bollman, S.L., Kells, J.J., Penner, D. (2006) Weed Response to Mesotrione and Atrazine Applied Alone and in Combination Preemergence. *Weed Technology*, 20(4), 903-907.

²¹ Hugie, J., Bollero, G., Tranel, P., Riechers, D. (2008) Defining the Rate Requirements for Synergism between Mesotrione and Atrazine in Redroot Pigweed (*Amaranthus retroflexus*). *Weed Science*, 56(2), 265-270.

²² Walsh, M., Stratford, K., Stone, K., Powles, S. (2012) Synergistic Effects of Atrazine and Mesotrione on Susceptible and Resistant Wild Radish (*Raphanus raphanistrum*) Populations and the Potential for Overcoming Resistance to Triazine Herbicides. *Weed Technology*, 26(2), 341-347.

²³ Syngenta. (2015) Acuron Technical Bulletin. Acuron™ corn herbicide defeats tough weeds current products are missing, Page 22. Downloaded on 6/30/2016 from: <http://www.syngentacropprotection.com/prodrender/imagehandler.ashx?ImID=d40b0089-7648-491d-9d4f-c4f1c92d27bb&fTy=0&et=8>. PDF of bulletin is on file with the authors.

²⁴ The Center has initiated litigation challenging the EPA's failure to consider the impacts of this approval on threatened and endangered species. See https://www.biologicaldiversity.org/news/press_releases/2015/pesticides-06-18-2015.html.

²⁵ Dow Agrosciences LLC, Wang, Peng, Huang, Jim X., Dripps, James E., Yu, Alisa Y. (WO2015196339) SYNERGISTIC EFFECT OF SPINETORAM AND METHOXYFENOZIDE FOR CONTROL OF STEM BORER ON RICE. International patent application # PCT/CN2014/080526, filed June 23rd, 2014.

²⁶ USPTO. USPTO Will Begin Publishing Patent Applications. November 27th, 2000. Available at: <http://www.uspto.gov/about-us/news-updates/uspto-will-begin-publishing-patent-applications>.

²⁷ Bayer Cropscience LP, Reid, Byron L, Baker, Robert B, Bao, Nanggang N, Koufas, Deborah A, Kent, Gerald J, Baur, Peter. (Patent # 8,404,260). Synergistic pesticide compositions. USPTO Application number 12/410,840, filed March 25th 2009. This is an example of a patent application that demonstrates synergy between the active ingredient imidacloprid and commonly used inert ingredients.

²⁸ 40 C.F.R. § 159.195(a).

²⁹ 7 U.S.C. § 136d(a)(2).

³⁰ Found here: <https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>.

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³⁶ Colby, S.R. (1967) Calculating Synergistic and Antagonistic Responses of Herbicide Combinations. *Weeds*, 15(1), 20-22.

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
Sent: 9/18/2017 5:34:51 PM
To: Meadows, Sarah [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=cd0a1144a9164fa99adca52f94ca199a-Meadows, Sa]
CC: Rowland, Grant [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=5b004bc79f1f40b0a181a584a8c64495-Rowland, Grant]
Attachments: Draft letter.docx

See if this helps.

REUBEN BARIS | ACTING CHIEF | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 9/1/2017 4:01:51 PM
To: Meadows, Sarah [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=cd0a1144a9164fa99adca52f94ca199a-Meadows, Sa]
Attachments: Dicamba Changes for Registrant (internal use only).docx; Dicamba Changes for Registrant (final).docx

*Grant Rowland
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703-347-0254*

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/25/2016 4:50:01 PM
To: Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
Subject: EFED Dicamba Risk assessments (final)
Attachments: Section 3 new use (soybean).pdf; Section 3 new use (soybean) addendum #2.pdf; Section 3 new use (soybean) addendum #1.pdf; Section 3 new use (cotton).pdf; Endangered Species Assessment (ESA) Phase 3+4.pdf; Endangered Species Assessment (ESA) phase 2.pdf; Endangered Species Assessment (ESA) Phase 1.pdf

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

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420352, 421434, 421723

Date: March 24, 2016

MEMORANDUM

Subject: Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin).

To: Grant Rowland, Risk Manager
Kay Montague, Product Manager Team 23
Dan Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)
Office of Pesticide Programs

From: Elizabeth Donovan, M.S., Biologist *ED* 3/24/16
Michael Wagman, M.S., Biologist *MW* 3/24/16
Monica Wait, Risk Assessment Process Leader *Monica Wait* 3/24/16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Through: Mark Corbin, Branch Chief *Mark Corbin* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Prior to conducting this refined Endangered Species Assessment, the Environmental Fate and Effects Division (EFED) performed a screening level ecological risk assessment for a Federal action involving proposed new uses of the diglycolamine salt of dicamba (dicamba DGA) on dicamba herbicide-tolerant soybean on March 8, 2011 (DP 378444); an amendment to the assessment was issued on May 20, 2014 (DP 404138, 404806, 405887, 410802, and 411382). Concurrent with this refined Endangered Species

Assessment, a Section 3 New Use dicamba DGA salt on dicamba-tolerant cotton screening-level assessment (DP 404823) and a subsequent addendum for the use of dicamba DGA on dicamba-tolerant soybean (DP 426789) that addresses multiple issues (risk to terrestrial invertebrates, spray drift buffers, runoff, and updated mammalian toxicological endpoints for parent dicamba and its degradate DCSA) have been finalized. As a result of the analyses in the screening level risk assessments and the new addendum (DP 426789), potential direct risk concerns could not be excluded for:

- mammals (chronic, from the soybean use only, due to residues from dicamba's metabolite, DCSA, rather than from parent dicamba);
- birds (acute from parent dicamba for both soybean and cotton uses; chronic from DCSA residues only in soybean but not cotton), considered surrogates for reptiles, and terrestrial-phase amphibians; and
- terrestrial plants (soybean and cotton uses).

In the screening level risk assessments, indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Additionally, the screening level assessment showed that direct risk concerns were unlikely (*i.e.* levels of concern were not exceeded) for:

- mammals (acute) and (chronic—for the cotton use only);
- birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton);
- terrestrial insects (acute and chronic);
- freshwater fish (acute and chronic);
- aquatic-phase amphibians (acute and chronic);
- estuarine/marine fish (acute and chronic);
- freshwater invertebrates (acute and chronic); estuarine/marine invertebrates (acute and chronic); and
- aquatic plants¹

The screening assessment for dicamba DGA on dicamba-tolerant cotton (D404823) and the recent addendum to the screening level risk assessment for the use of dicamba DGA on dicamba-tolerant soybean (D426789) used updated terrestrial mammal endpoints for dicamba and its metabolite, DCSA.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each screening step, EPA compares the more refined exposures to the toxicity of the pesticide active

¹ The listed species LOC was exceeded for non-vascular aquatic plants, however there are no listed species of this taxa.

ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still exceeds the Agency’s levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. When a given taxonomic RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon. If RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

The purpose of this document is to explain the refined risk assessment conducted for Federally-listed threatened or endangered (listed) species that could potentially be impacted by this pesticide registration. The refined assessment was conducted based on the 2004 Overview document, as discussed above. The assessment of risks to listed species posed by the use of Dicamba DGA has been conducted in phases covering a specific set of states, assessing risk to all the listed species covered in those states. This assessment covers the endangered species analysis for 16 states: Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin. Based on EFED’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), 183 species in the 16 states proposed for registration were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant soybean and cotton uses. **Table 1** presents a summary of this assessment. Separate concurrent assessment phases cover the endangered species analysis for 7 states (D422305, covering AL, GA, KY, MI, NC, SC, and TX) and 11 states (D425049, covering AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV).

EPA consulted U.S. Fish and Wildlife Service Recovery Plans to determine whether listed species in these states would be expected to occur in an action area encompassing the treated soybean and corn fields. The refined assessment was then conducted on those species that could not be excluded from the action area. EPA also consulted the recovery plans in the refined assessment for additional habitat information and incorporated species biological information regarding dietary items (used to model dicamba DGA residues in prey tissue) and body weight (used to determine food consumption rates and scale ecotoxicity data from the tested surrogate species, the bobwhite quail and rat, to the body weight of the listed species).

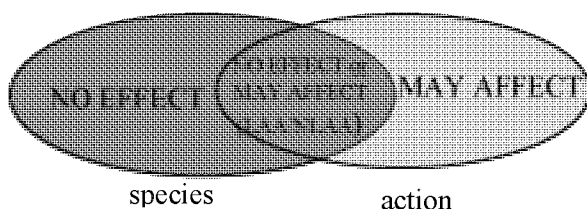
Table 1. Summary of species effects determinations and critical habitat modification determinations for Federally listed threatened or endangered species in AR, IL, IA, IN, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI for dicamba DGA use on genetically modified cotton and soybeans.

Species	Effects Determination	Comments
Spring Creek Bladderpod	May Affect, Likely to Adversely Affect	Found in Wilson Co., TN
All other species (terrestrial and aquatic)	No Effect	None
Critical Habitat	Modification Determination	Comments
All Critical Habitats	No Modification	None

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have **NO EFFECT**.
- For listed individuals outside the action area, use of a pesticide would be determined to fall under **NO EFFECT**.
- Listed individuals inside the action area may either fall into the **NO EFFECT** or **MAY AFFECT** (**LIKELY** or **NOT LIKELY TO ADVERSELY AFFECT**) categories depending upon their specific biological needs, circumstances of exposure, etc.



- **LIKELY** or **NOT LIKELY TO ADVERSELY AFFECT** determinations are made using the following criteria:
 - Insignificant - The level of the effect cannot be meaningfully related to a “take.”
 - Highly Uncertain - The effect is highly unlikely to occur.
 - Wholly beneficial - The effects are only good things.

Spray Drift Mitigation

EFED's refined endangered species risk assessment took into account the spray drift mitigation language that was added to the most recent proposed label submitted by the registrant. An accounting of federally-listed threatened or endangered species within the 16 states (covered in this assessment) proposed for dicamba DGA use on genetically modified cotton and soybeans is included in **Appendix 1** (183 species). Specifically, the spray drift mitigation language on the M1691 Herbicide Supplemental labels for the use dicamba DGA salt on **ROUNDUP READY 2 XTEND™** soybean and **BOLLGARD II® XTENDFLEX** cotton includes the following limitations:

- Specifying the use of a nozzle (Tee Jet® TTI1004) with ASABE S-572 ultra-coarse and extremely coarse droplet spectra and a maximum operating pressure of 63 psi.
- A maximum equipment ground speed of 15 miles per hour and ground boom height of 24 inches above the target pest or crop canopy.
- Restricting all applications when wind speeds are < 3 mph or > 15 mph and restricting applications when wind is blowing towards sensitive areas at > 10 mph. Maintaining use of a 110 foot in-field buffer for a 0.5 lb a.i./A application (220 foot in-field buffer for a 1 lb a.i./A application) when the wind is blowing towards any areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures.
- Applications done in low relative humidity conditions are to use equipment set to produce larger droplet spectra to compensate for evaporation.
- Applications are not be conducted during temperature inversions.
- In order to prevent effects to non-target susceptible plants, the label also includes the following language: “do not apply under circumstances where spray drift may occur to food, forage or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants because severe injury or destruction may result, including plants in a greenhouse. Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from the off-target movement of M1691 Herbicide. The Applicator must survey the application site for neighboring sensitive areas prior to application. The applicator also should consult sensitive crop registries for locating sensitive areas where available.”
- Finally, in order to prevent unintended damage from the drift of M1691 Herbicide, the label says not to apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

The incorporation of the spray drift mitigation measures into the product labeling as outlined above would result in exposure to dicamba DGA from spray drift at a level where effects are expected only within the confines of the treated field and so the action area is limited to the dicamba DGA treated field. Further, the incorporation of the “susceptible plants” spray drift mitigation language on the label is to avoid damage to these plants (including adjacent crops). Because the risk assessment interprets the threshold for plant damage concern to be based on the most sensitive plant species tested and the screening level ecological risk assessment has demonstrated that these plant effects endpoints constitute the most conservative terrestrial organism levels of effect, it is concluded that the “susceptible plants” requirement requires a level of drift mitigation that would also prevent less sensitive organisms from being exposed at levels of concern. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to dicamba DGA, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any effects thresholds of concern. Additionally, as indicated in the screening level ecological risk assessments for cotton and soybean, no aquatic receptor taxa are of concern for drift or runoff exposure (LOCs were not exceeded for aquatic taxa). **Consequently, all but 10 of the listed species originally identified as potentially at-risk are determined to be given a “no effect” (NE) without further refinement because they are not expected to occur in an action area encompassing the treated soybean and cotton fields (Appendix 2).** The remaining 10 species are assessed using the refinements set forth in the 2004 Overview document referred to earlier in this assessment.

Exposure through Runoff

The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted concentrations from modeling were lower than the most sensitive taxa's endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a "no effects" determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would also protect against the risk of exposure to listed species off the treated field.

In addition to the spray drift and runoff mitigation measures contained in the proposed labeling, EFED analyzed species-specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment. An accounting of the federally-listed threatened or endangered species within the 16 states proposed for this registration showed 183 listed species as potentially at risk (direct or indirect effects) as a result of the screening-level assessment (**Appendix 1**). The spray drift mitigation label language cannot preclude listed species being exposed to dicamba DGA salt or DCSA residues on treated fields, should a listed species utilize such areas as part of its range and corresponding habitat. Of the 183 listed species within the 16 states (AR, IL, IN, IA, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, WI) considered part of the proposed Federal decision, the following 10 species were reasonably expected to occur on soybean and cotton fields, which could potentially be treated with dicamba and therefore could not be assumed to be "no effect" solely on the basis of occurrence outside the action area:

- gray wolf (*Canis lupis*)
- Indiana bat (*Myotis sodalis*)
- Ozark bat (*Corynorhinus townsendii ingens*)
- Louisiana black bear (*Ursus americanus luteolus*)
- whooping crane (*Grus americana*)
- Mississippi sandhill crane (*Grus canadensis pulla*)
- lesser prairie-chicken (*Tympanuchus pallidicinctus*)
- gopher tortoise (*Gopherus polyphemus*)
- American burying beetle (*Nicrophorus americanus*)
- Spring Creek bladderpod (*Lesquerella perforata*)

Therefore, species specific biological information (e.g., body size, dietary requirements, and seasonality) and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations.

This assessment also uses the refined exposure values determined in the cotton screening level assessment and the concurrently issued addendum to the soybean screening level risk assessment documents compared to the initial exposure estimates from the soybean screening level assessment. This ESA assessment also evaluates chronic exposures from DCSA separately from the chronic exposure to parent

dicamba. Dicamba exposure values were determined from the upper bound of the modeled T-REX run for exposures following spray applications based on the Kenaga nomogram modified by Fletcher *et al* (1984), which is based on a large set of actual field residue data. Modeled dicamba exposure values were identical between the soybean addendum and the cotton screening level risk assessment (since the maximum application rates and minimum application intervals are the same).

Similar modeling of DCSA residues, which are formed inside the tolerant-soybean and tolerant-cotton plants through plant metabolism, is not feasible at this time due to a lack of sufficient data tracking DCSA residues in plant tissues over time to ascertain degradation rates. Therefore, in the soybean addendum and the cotton screening-level risk assessment, EFED used the maximum empirical measured DCSA residue concentrations in dicamba-tolerant soybean (61.1 mg/kg (ppm) DCSA in broadleaf plants and 0.440 ppm in soybean seeds) and cotton plant tissues (6.29 ppm DCSA in cotton gin byproducts and 0.27 ppm in undelinted cotton seed) to evaluate chronic exposures to DCSA for animals foraging on soybean and cotton plants. Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed soybean/cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications (*i.e.* arthropod concentrations estimated to be approximately 70% of the concentrations in broadleaf plant tissues or 42.5 ppm DCSA in arthropods feeding on soybean plants and 4.4 ppm in arthropods feeding on cotton plants). The empirical residue data for cotton indicated that chronic exposures of birds and mammals to dicamba or DCSA in cotton tissues *would not* be above any levels of concern. Although the concurrently issued soybean addendum indicates that chronic risk to mammals and birds was only a concern from DCSA residues in plant/prey tissues *and not from residues of parent dicamba*, since the original soybean screening-level assessment (USEPA, 2011) indicated chronic risk to mammals, this assessment presents the estimated exposures and comparisons to threshold toxicity values for both dicamba and DCSA for mammals, but evaluates them separately since their chronic toxicity and exposure profiles differ greatly. For birds, following the conclusions of the screening level assessments and the soybean addendum, only acute risk from dicamba exposures and chronic risk from DCSA exposures is evaluated.

Critical Habitat Analysis

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis (**Appendix 3**) consistent with the Overview Document (USEPA, 2004) as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species.

The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Refined ecological risk assessment for the remaining species potentially exposed to dicamba and DCSA residues

For the effects determinations for whooping crane, sandhill crane, lesser prairie chicken, gopher tortoise, American burying beetle, spring creek bladderpod, Indiana bat, Ozark bat, gray wolf and Louisiana bear,

a refined risk assessment approach was used to evaluate additional lines of evidence to determine whether the conservative generic assumptions in the screening risk assessment apply to a particular species of interest (*e.g.* the whooping crane). In the example of the whooping crane, the refined risk assessment investigated the impacts of more crane-specific data related to:

1. Bird size (as the crane is larger than the 1000g large bird category used in the initial screen)
2. Bird food consumption tailored to:
 - a. The true weight of the bird
 - b. Energy requirements of the crane
 - c. Improvement on the generic food intake model of the screen to assess energy content of the diet and the actual free living energy requirements of a bird the size of a crane
3. Toxicity endpoints were scaled from the weight of the tested surrogate species (bobwhite quail) to reflect the comparatively larger actual size of the whooping crane.

Using the whooping crane as the example to show how EPA made its effects determinations, EPA determined that the whooping crane could be feeding on arthropod prey in treated cotton and soybean fields during its migration from March to May. As stated above, for acute and chronic exposures to dicamba, EPA used the upper bound predicted concentrations of dicamba DGA salt found on arthropods from T-REX modeling. For chronic exposures to DCSA residues, EPA used the maximum measured concentrations found in broadleaf plants, modified by the Kenaga relationship between broadleaf plants and arthropods. This prey analysis is consistent with the preliminary risk concerns identified in the screening assessment. This analysis is conservative as it assumes 1) that 100% of the crane's food consumption comes from exposed arthropods and 2) the level of dicamba DGA residues assumed to be on these prey arthropods is based on the upper bound Kenaga residues expected for arthropods directly exposed to spray applications of dicamba DGA and for exposure to DCSA that residues in the arthropod prey item are based on the maximum measured values in broadleaf plant tissues modified by the Kenaga relationship between residues in arthropods and broadleaf plants following spray applications. EPA determined the field metabolic rate of the whooping crane through the use of a published peer reviewed allometric equation that relates bodyweight to energy requirements. From there the mass of prey consumed per day is determined by dividing the field metabolic rate (kcal/day) by the energy content of the arthropod prey and an assimilation factor that accounts for the ability of birds to absorb that energy from the diet. Values were obtained from a published peer reviewed EPA document produced by the Office of Research and Development for Agency-wide use in conducting ecological risk assessment (Wildlife Exposure Factors Handbook, USEPA, 1993). The mass of dicamba DGA in the insect diet is determined from the T-REX run found in the addendum to the soybean screening-level risk assessment (USEPA, 2016a), issued concurrently with this risk assessment while the mass of DCSA in insect diet was assumed to be 42.5 ppm (70% of the maximum measured residues in soybean hay of 61.1 ppm). The mass of prey consumed per day is then multiplied by the mass of dicamba or DCSA in the insect diet to determine the mass of dicamba or DCSA in the crane's daily diet in mg/day. Then the daily dose that the crane (considering its bodyweight) receives is determined by multiplying the mass of dicamba or DCSA in the daily diet of arthropods (assuming that is the only food item) times the mass of prey consumed per day divided by the bodyweight of the crane. Then EPA scaled the acute toxicity endpoint (based on the most sensitive tested surrogate bird species, bobwhite quail's default weight of 178 grams) to the bodyweight of the whooping crane to determine the acute oral toxicity for the crane. For exposures to

DCSA residues, the chronic toxicity endpoint for the mallard (the most sensitive tested species) was modified by the relationship between the chronic dicamba and DCSA endpoints for rats (a 17x difference). The acute RQ for dicamba exposures is then calculated by dividing the daily dose of dicamba from consuming arthropods by the acute oral toxicity endpoint while the chronic RQ is calculated by dividing the daily dose of DCSA by the chronic toxicity endpoint. In this case the acute RQ for dicamba was 0.03, which is below the endangered species level of concern of 0.1, while the chronic RQ for DCSA was 0.11, which is below the listed and non-listed species chronic LOC of 1.0. At this point, EPA was able to conclude that dicamba and its metabolite DCSA would not have a direct effect on the whooping crane.

Birds

The screening-level assessments showed that birds could be at risk of mortality from acute exposures to dicamba DGA on treated fields, but chronic risk to dicamba was not expected as no chronic RQs exceeded the Agency's LOC (1.0) for chronic risk (USEPA 2011. D378444, p. 15). The concurrently issued soybean addendum did indicate that chronic exposures to DCSA residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, for listed species that could reasonably be expected to occur on treated soybean and cotton fields, EPA conducted a refined assessment for acute (dicamba only) and chronic (DCSA only, and only for soybean) exposures. Of the bird species identified as potentially at acute risk in the sixteen states, three are reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

Whooping crane

Dicamba Acute Effects Assessment

Whooping cranes migrate from Texas to Canada from March 25th to May 1st (Canadian Wildlife Service and USFWS, 2007). Whooping cranes are omnivorous and during migration may feed on a variety of foods including frogs, fish, plant tubers, crayfish, insects and agricultural grains. EFED considered the upper bound T-REX predicted concentrations of DGA expected to be found on arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as modeled residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. Alternative terrestrial vertebrate prey and agricultural grains are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(5826)^{0.749} = 757.6$ kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = $757.6 \text{ kcal/day} / (1.7 \text{ kcal/g} \times 0.72 \text{ AE}) = 619$ g/day

Mass of DGA in insect diet 102.99 mg/kg-bw from T-REX run

Mass of DGA in daily diet mg = 619 g/day X 102.99 mg DGA/kg bird prey X 0.001 = 63.75 mg/day

Daily dose in crane = 63.75 mg DGA/day/5.826 kg = **10.94 mg/kg-bw/day**

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the crane is:

Crane LD50 mg/kg-bw = 188 mg/kg-bw (5826/178)^(1.15-1) = **317.25mg/kg-bw**

RQ for daily acute exposure for three applications, peak exposure number: RQ = 10.94/317.25 = **0.03**.

An RQ of 0.03 does not exceed the acute LOC of 0.1; **consequently a “no effect” determination is concluded for the whooping crane.**

DCSA Assessment for Whooping Crane consuming prey that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. Alternative terrestrial vertebrate prey and agricultural grains are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = 1.146(5826)^{0.749} = 757.6 kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = 757.6 kcal/day/(1.7 kcal/gX0.72 AE) = 619 g/day

Mass of DCSA in insect diet 42.5 mg/kg-bw (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet mg = 619 g/day X 42.5 mg DCSA/kg bird prey X 0.001 = 26.31 mg/day

Daily dose in crane = 26.31 mg DCSA/day/5.826 kg = **4.52 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: RQ = 4.52/40.88 = **0.11**

An RQ of 0.11 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the whooping crane.**

Mississippi sandhill crane

Sandhill cranes are known to feed on farms nearby the Mississippi Sandhill Crane National Wildlife Refuge that they inhabit (USFWS, 1991). Cranes feed on adult and larval insects, earthworms, crayfish, small reptiles, amphibians, roots, tubers, seeds, nuts, fruits and leaves. EFED considered the upper bound T-REX predicted concentrations of DGA expected to be found on arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as modeled residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. Alternative terrestrial vertebrate prey are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(2500)^{0.749} = 402.01$ kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = $402.01 \text{ kcal/day} / (1.7 \text{ kcal/g} \times 0.72 \text{ AE}) = 328.44 \text{ g/day}$

Mass of DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet mg = $328.44 \text{ g/day} \times 102.99 \text{ mg DGA/kg bird prey} \times 0.001 = 33.82 \text{ mg/day}$

Daily dose in crane = $33.82 \text{ mg DGA/day} / 2.5 \text{ kg} = 13.53 \text{ mg/kg-bw/day}$

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the crane is:

Crane LD50 mg/kg-bw = $188 \text{ mg/kg-bw} (2500/178)^{(1.15-1)} = 279.44 \text{ mg/kg-bw}$

RQ for daily acute exposure for three applications, peak exposure number: $RQ = 13.53/279.44 = 0.05$.

An RQ of 0.05 is less than the acute LOC of 0.1; **consequently a “no effect” determination is concluded for the Mississippi sandhill crane.**

DCSA Assessment for Mississippi sandhill crane consuming prey that had previously fed on soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants

that had the highest measured DCSA residues. Alternative terrestrial vertebrate prey and agricultural grains are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(2500)^{0.749} = 402.01$ kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = $402.01 \text{ kcal/day} / (1.7 \text{ kcal/g} \times 0.72 \text{ AE}) = 328.44 \text{ g/day}$

Mass of DCSA in insect diet 42.5 mg/kg-bw (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet mg = $328.44 \text{ g/day} \times 42.5 \text{ mg DCSA/kg bird prey} \times 0.001 = 13.96 \text{ mg/day}$

Daily dose in crane = $13.96 \text{ mg DGA/day} / 2.5 \text{ kg} = 5.58 \text{ mg/kg-bw/day}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $= 5.58 / 40.88 = 0.14$.

An RQ of 0.14 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Mississippi sandhill crane**

Lesser prairie chicken

The lesser prairie chicken makes use of agricultural fields at specific times of the year. However, as explained below, all available lines of evidence indicate the use of cotton and soybean fields is limited temporally and that the agricultural field is not an ideal habitat for the species because conversion of rangelands to cropland has reduced lesser prairie-chicken populations greatly since the early 1900's (Giesen 1998). An analysis of exposure potential for dicamba DGA use and lesser prairie chickens focused on the seasonal use of soybean and cotton fields by the birds as well as the likely food consumption during those periods.

Available information suggests that the birds do not use agricultural fields during the nesting and rearing cycle. Nesting lesser prairie chickens have been observed to establish nest sites deep within native prairie habitat and similar grass land that affords adequate cover and an understory that allows the young to move. Within these areas, nesting sites are observed to be situated far from edge areas (Jamison, 2000 and Hagen et al. 2007). A review of nesting and brood rearing habitat studies indicates that hens nest in tall, residual grasses or under shrubs in native pasture avoiding shortgrass habitats and cultivated fields and transition to habitats for rearing brood that can be described as areas with abundant bare ground and approximately 25% canopy cover of shrubs, forbs, or grasses <30 cm in height (Jamison, 2000). In Jamison's review of almost a dozen studies of nesting and brood rearing habitat, cotton and soy fields are not included as habitat used by the birds. Similarly, spring and summer foraging habitat has been

summarized as including grasses and forbs less than 80 cm in height (Jamison, 2000). In all studies of spring and summer habitat there is no inclusion of cotton or soybean as a cover type utilized by the birds during nesting, brood rearing or foraging.

In contrast to the spring and summer months, the lesser prairie chicken in Finney County of southwestern Kansas has been observed commonly foraging in agricultural fields such as harvested fields of irrigated corn during fall and winter (Jamison, 2000) and this pattern has been confirmed by a radiotelemetry study (Salter et al. 2005). Rob and Schroeder (2005) report similar use of soybean fields by the birds as a fall and winter source of seed and Jamison (2000) cited 17 studies reporting the use of sorghum, corn and other grain fields as fall and winter foraging habitat in areas adjacent to prairie chicken grassland habitat. This utilization of cropland during the fall and winter months for the present waste grain is further supported by Jamison et al. (2002) in their review of 25 habitat studies for the lesser prairie chicken (summarized in **Appendix 5**). Despite cropland comprising a cover type in many of these studies, observations of its actual use are confined to the fall and winter months and consumption of waste grain. The available information indicates that the lesser prairie chicken is attracted to corn and soybean fields in the fall and winter months, where the birds exploit waste seed as an important over-wintering food source.

Based on the reports of over two dozen studies spanning multiple sites across the lesser prairie chicken established range, it is reasonable to expect that utilization of cotton and soybean by lesser prairie chickens occurs during the fall and winter months and is associated with the consumption of waste grain and seed in the fields. However, it is unlikely, given the toxic gossypol content of cotton seed, that the plant provides similar resources as corn and soybean for the bird. This is supported by the position of Timmer (2012) which states that cotton is not considered habitat for this species. Consequently, the exposure refinement for the labeled dicamba DGA product use on soybean and cotton should focus on the consumption of soybean seeds. This may still be considered conservative as 100% of the chicken's diet would be considered to consist of exposed seed receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(730)^{0.749} = 159.89$ kcal/day (USEPA 1993, body weight The Birds of North America, No. 364, 1998)

Mass of seed consumed per day = $159.89 \text{ kcal/day} / (4.6 \text{ kcal/g} \times 0.59 \text{ AE}) = 58.91 \text{ g/day}$

Mass of DGA in seed diet 16.43 mg/kg-ww from T-REX run

Mass of DGA in daily diet mg = $58.91 \text{ g/day} \times 16.43 \text{ mg DGA/kg bird prey} \times 0.001 = 0.97 \text{ mg/day}$

Daily dose in chicken = $0.97 \text{ mg DGA/day} / 0.73 \text{ kg} = \mathbf{1.33 \text{ mg/kg-bw/day}}$

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the chicken is:

Chicken LD50 mg/kg-bw = $188 \text{ mg/kg-bw} (737/178)^{(1.15-1)} = \mathbf{232.32 \text{ mg/kg-bw}}$

RQ for daily acute exposure for three applications, peak exposure number: $RQ = 1.33/232.66 = 0.01$.

An RQ of 0.01 does not exceed the acute LOC of 0.1; **consequently EPA makes a “no effect” determination for the lesser prairie chicken.**

DCSA Assessment for lesser prairie chicken consuming soybean seeds

As above, the exposure for DCSA residues in soybean and cotton should focus on the consumption of soybean seeds. This may still be considered conservative as 100% of the chicken's diet would be considered to consist of exposed seed receiving maximum measured residues in soybean seed. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(730)^{0.749} = 159.89$ kcal/day (USEPA 1993, body weight The Birds of North America, No. 364, 1998)

Mass of seed consumed per day = $159.89 \text{ kcal/day} / (4.6 \text{ kcal/g} \times 0.59 \text{ AE}) = 58.91 \text{ g/day}$

Mass of DCSA in seed diet 0.44 mg/kg-ww (max residues from empirical data on dicamba-tolerant soybean seed).

Mass of DCSA in daily diet mg = $58.91 \text{ g/day} \times 0.44 \text{ mg DCSA/kg bird prey} \times 0.001 = 0.026 \text{ mg/day}$

Daily dose in chicken = $0.026 \text{ mg DCSA/day} / 0.73 \text{ kg} = 0.036 \text{ mg/kg-bw/day}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (34x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure for three applications, peak exposure number: $RQ = 0.036/40.88 = <0.01$.

An RQ of <0.01 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the lesser prairie chicken.**

Reptiles and amphibians

Using birds as a surrogate for reptiles and terrestrial-phase amphibians, consistent with the Overview document (USEPA, 2004), the screening level assessment suggests that reptiles and terrestrial-phase amphibians could be at risk of effects from acute exposures to dicamba DGA or chronic exposures to DCSA on treated fields. Of the reptile and amphibian species identified as potentially at risk in the sixteen states, one reptile is reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for that species.

Gopher tortoise

The gopher tortoise inhabits droughty, deep sand ridges, xeric communities, originally longleaf pine-scrub oak, and may also be found along fence rows, field edges, power lines, and in pastures (USFWS, 1990). The tortoise feeds on plant material, such as leaves and grass. EFED considers the maximum T-REX predicted concentrations of DGA expected to be found on short grass as a conservative pesticide load in the dietary items. This is considered conservative as it assumes 100% of the tortoise's diet is exposed short grass (for which modeled T-REX residues are higher than any other dietary item) receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

$$\text{Field metabolic rate kcal/day} = 0.019(4500)^{0.841} = 22.44 \text{ kcal/day (USEPA 1993)}$$

$$\text{Mass of soybean plants consumed per day} = 22.44 \text{ kcal/day} / (1.3 \text{ kcal/g} \times 0.47 \text{ AE}) = 36.73 \text{ g/day}$$

$$\text{Mass of DGA in short grass diet} = 262.94 \text{ mg/kg-ww from T-REX run}$$

$$\text{Mass of DGA in daily diet mg} = 36.73 \text{ g/day} \times 262.94 \text{ mg DGA/kg tortoise prey} \times 0.001 = 9.66 \text{ mg/day}$$

$$\text{Daily dose in tortoise} = 9.66 \text{ mg DGA/day} / 4.5 \text{ kg} = \mathbf{2.15 \text{ mg/kg-bw/day}}$$

Appropriate scaling factors are not available for reptiles and amphibians so the acute toxicity value for the bobwhite quail (most sensitive avian species for which acute data are available) serves as a surrogate (USEPA, 2004) toxicity value for the tortoise:

$$\text{Tortoise LD50 mg/kg-bw} = \mathbf{188 \text{ mg/kg-bw}}$$

$$\text{RQ for daily acute exposure for three applications, peak exposure number: } \text{RQ} = 2.15 / 188 = \mathbf{0.01}.$$

An RQ of 0.01 less than the acute LOC of 0.1; **consequently a “no effect” determination is concluded for the gopher tortoise.**

DCSA Assessment for gopher tortoise consuming soybean forage

As above, the tortoise feeds on plant material, such as leaves and grass. EFED considers the maximum measured DCSA residues in soybean tissue as a conservative pesticide load in the dietary items. This is considered conservative as it assumes 100% of the tortoise's diet is exposed soybean leaves/stems, which would have the highest DCSA residues. A biologically representative refinement to the screening assessment follows:

$$\text{Field metabolic rate kcal/day} = 0.019(4500)^{0.841} = 22.44 \text{ kcal/day (USEPA 1993)}$$

$$\text{Mass of soybean plants consumed per day} = 22.44 \text{ kcal/day} / (0.63 \text{ kcal/g} \times 0.47 \text{ AE}) = 75.79 \text{ g/day}$$

$$\text{Mass of DCSA in soybean forage (broadleaf plant) diet} = 61.1 \text{ mg/kg-ww from max residues from empirical data on dicamba-tolerant soybean forage}$$

Mass of DCSA in daily diet mg = 75.79 g/day X 61.1 mg DCSA/kg tortoise prey X 0.001 = 4.63 mg/day

Daily dose in tortoise = 4.63 mg DCSA/day/4.5 kg = **1.03 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck (surrogate for reptiles) for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (34x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 1.03/40.88 = 0.03$.

An RQ of 0.03 less than the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the gopher tortoise.**

Terrestrial Invertebrates

The screening-level risk assessments (USEPA, 2011 D378444 and USEPA, 2016b D404823) did not identify risk concerns for terrestrial invertebrates. Additional analyses in the first addendum to the soybean assessment (USEPA, 2014. D404138+) and the subsequent addendum issued concurrently with this ESA assessment (USEPA, 2016a) indicate that using a screening approach and given the available empirical toxicological data for terrestrial invertebrates showing that dicamba is practically non-toxic to honey bees, acute contact (from exposure to direct sprays of dicamba) and acute dietary (from exposure to dicamba residues in pollen and nectar) risks are not anticipated (*i.e.* acute oral and dietary exposures were below LOCs) to arthropods under the proposed use patterns for dicamba on tolerant soybean and cotton. Though the chronic toxicity of dicamba to adult and larval honey bees is more uncertain, EPA’s analysis from the concurrent soybean addendum and cotton assessment using chronic data for other invertebrates (*i.e.* daphnids) also indicates that chronic toxicity to honey bees and other terrestrial invertebrates is anticipated to be low. No other data has been submitted to the Agency for dicamba’s toxicity to other arthropods.

No data is available for the acute or chronic toxicity of dicamba’s degradate DCSA to honey bees or other pollinators. Although EFED used the toxicity differential between the chronic mammalian studies with dicamba and DCSA to estimate a chronic endpoint for avian organisms, such an approach is not considered appropriate for terrestrial organisms given the greater differences in species biology between arthropod taxa compared to birds and mammals. However, based on the available data including the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

Despite the addendum and screening-level conclusions that direct risk from dicamba DGA to terrestrial invertebrates is not anticipated, EPA investigated whether there were any arthropod species on treated soybean and cotton fields that might be indirectly impacted by the effect of dicamba on plants on the treated field. One arthropod is reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific habitat information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for that species.

American burying beetle

Habitat use and dependencies were explored to determine if any effects on plants would indirectly affect the burying beetle. Except where noted, the information was sourced from the Recovery Plan for the species (USFWS, 1991). The American burying beetle is a carnivorous species. Adults feed on a variety of carrion as well as live insects. The larvae are reared on cached (buried) carrion. Consequently, any effect of dicamba DGA would be mediated through the availability of vegetative cover for the species because direct toxic effects are not expected, and plants do not constitute a necessary food component. Variable habitat and wide soil types make its habitat difficult to describe in anything other than broad terms.

The species exhibits broad vegetation tolerances (from large mowed and grazed fields to dense shrub thickets), though natural habitat may be mature forests. The species has been recorded in grassland, old field shrubland, and hardwood forests. For example, the Block Island population (Rhode Island) occurs on glacial moraine dominated by maritime scrub-shrub community. Plant species include bayberry, shadbush, goldenrod, and various non-native plants. Oklahoma habitats vary from deciduous oak-hickory and coniferous forests atop ridges or hillsides to deciduous riparian corridors and pasturelands on valley floors.

Based on the available data, there are no direct toxicological effects to the burying beetle. Likely, the only potential mechanism for an indirect effect from dicamba would be a reduction in cover provided by plants. The Recovery Plan (USFWS 1991) indicates that vegetative structure and soil types are unlikely to be limiting factors for the burying beetle given its broad historical geographic range. Furthermore, the apparent persistence of the beetle on Block Island suggests broad vegetation (landscape) tolerances. Given that applications of dicamba DGA will occur when the crop is intact, the field is expected to maintain sufficient vegetative cover for the burying beetle. **Consequently, a “no effect” determination is concluded for the American burying beetle.**

Terrestrial Plants

The screening level risk assessment showed that dicot plant species, but not monocots, would be at risk of adverse effects from dicamba applications. Of the terrestrial plant species identified as potentially at risk in the sixteen states, one plant species is reasonably expected to occur on treated soybean and cotton fields.

Spring Creek Bladderpod

Dicamba is highly toxic to broadleaf plant species (most sensitive NOAEC of 0.000261 lbs a.i./A for non-tolerant soybean) and given a maximum single application rate of 1.0 lbs a.i./A, it is assumed that any dicots on the field at the time of application would be considered to be at risk. The Spring Creek bladderpod (a dicot in the Brassicaceae family), is found in northern Wilson County, Tennessee in the watersheds of Spring Creek, Bartons Creek, and Cedar Creek. It is located primarily in the floodplain, in agricultural fields, as well as pastures, glades, and disturbed areas. It is found mainly on newly disturbed sites and requires some degree of annual disturbance to complete its lifecycle (USFWS 2006).

This species is a winter annual that “germinates between September and early October, overwinters as a small rosette of leaves, and fully develops and flowers the following spring. Full sun is required for

optimum growth. Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn,” when the cycle starts over again (USFWS, 2006). “If conditions are not suitable for germination the following fall, the seeds can remain dormant (but viable) for several years” (USFWS 1996).

It is likely that the species is in flowering stage when dicamba DGA is applied to soybean and cotton fields in the early season. **Consequently, EPA makes a “may effect, likely to adversely affect” determination for the Spring Creek bladderpod.**

Mammals

The screening-level assessments indicated that acute risk to mammals was not expected as no acute RQs exceeded the Agency’s LOC (0.1) for acute risk (USEPA 2011. D378444, p. 15). However, the soybean screening-level assessment (USEPA, 2011) indicated that mammals could be at reproductive risk from chronic exposures to dicamba DGA on treated fields, though the cotton screening level and concurrently issued soybean addendum (USEPA, 2016a and USEPA, 2016b) indicated that chronic exposures to dicamba DGA would be below the chronic LOC (1.0). This difference is due to soybean screening level risk assessment’s use of a chronic endpoint from the rat 2-generation study (MRID 43137101), of 45 mg/kg-bw for the NOAEL, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016c; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, as pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. Therefore, the cotton screening level risk assessment, the concurrently issued soybean addendum and this refined endangered species risk assessment use this revised NOAEL for dicamba DGA salt.

The concurrently issued soybean addendum did indicate that chronic exposures to dicamba’s metabolite, DCSA, residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency’s LOC for chronic risk. Therefore, EPA only conducted a refined assessment for chronic exposures to DCSA in soybeans for listed species that could reasonably be expected to occur on treated soybean fields.

Of the mammalian species identified as potentially at risk in the sixteen states, four are reasonably expected to occur on treated soybean fields. Species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for the four species potentially expected to occur on treated soybean fields.

Gray Wolf

According the USFWS Recovery Plan (USFWS 1982), gray wolves are habitat generalists that live throughout the northern hemisphere. Gray wolves are a carnivorous species that typically feed on ungulate species, such as deer. While not likely to feed on agricultural fields themselves, the primary prey species of the gray wolf may be expected to feed on plant material within the field during the period of applications. Based on this information, it is reasonable to conclude that the gray wolf may be exposed to dicamba DGA residues in prey. A biologically representative modification to the screening assessment

follows:

The first step in the refinement process is to calculate dicamba DGA residues in the prey species. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

$$1000 \text{ g mammal prey ingestion rate (dry)} = 0.621(1000)^{0.564} = 30.56 \text{ g /day}$$

$$1000 \text{ g mammal prey ingestion rate (wet)} = 30.56/0.2 = 152.8 \text{ g/day}$$

$$\text{Dicamba DGA residue in prey eating short grass from T-REX} = 262.94 \text{ mg dicamba DGA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{40.17 \text{ mg/kg-bw/day}}$$

The next step is to calculate the expected daily dose for a typical 17.7 kg (17700 g) gray wolf, the adjusted NOAEL value and the chronic dose-based RQ for the gray wolf based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.235(17700)^{0.822})/(1-0.69)/1000 = 2.35 \text{ kg wet/day}$$

$$\text{Dose-based EEC in wolf eating small mammal} = 40.17 \text{ mg/kg wet} \times 2.35/(17700/1000) = \mathbf{5.33 \text{ mg/kg-bw/day}}$$

$$\text{Adjusted NOAEL} = 136 \text{ mg/kg-bw } (350/17700)^{(0.25)} = \mathbf{51.00 \text{ mg/kw-bw}}$$

$$\text{Chronic Dose-Based RQ} = 5.33/51.00 = \mathbf{0.10}$$

An RQ of 0.10 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Gray Wolf.**

DCSA Assessment for Gray Wolf consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

$$1000 \text{ g mammal prey ingestion rate (dry)} = 0.621(1000)^{0.564} = 30.56 \text{ g /day}$$

$$1000 \text{ g mammal prey ingestion rate (wet)} = 30.56/0.2 = 152.8 \text{ g/day}$$

$$\text{DCSA residue in prey eating soybean forage/hay} = 61.1 \text{ mg DCSA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{9.34 \text{ mg/kg-bw/day}}$$

The next step is to calculate the expected daily dose for a typical 17.7 kg (17700 g) gray wolf, the adjusted NOAEL value and the chronic dose-based RQ for the gray wolf based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.235(17700)^{0.822})/(1-0.69)/1000 = 2.35 \text{ kg wet/day}$$

Dose-based EEC in wolf eating small mammal = $9.47 \text{ mg/kg wet} \times 2.35 / (17700 / 1000) = \mathbf{1.24 \text{ mg/kg-bw/day}}$

Adjusted NOAEL = $8 \text{ mg/kg-bw} (350 / 17700)^{(0.25)} = \mathbf{3.00 \text{ mg/kg-bw}}$

Chronic Dose-Based RQ = $1.25 / 3.00 = \mathbf{0.41}$

An RQ of 0.41 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Gray Wolf.**

Indiana Bat

The USFWS Recovery Plan (USFWS 2007) states that most Indiana bat maternity colonies have been found in agricultural areas with fragmented forests. According to the Recovery Plan there are some 235,000 individual bats within the hibernacula of the states subject to the proposed Federal action. The Recovery Plan also indicates that the sex ratio of males to females is roughly equal. Therefore, there are approximately 117,500 female bats within the hibernacula that are found in the states in this proposed Federal action.

While bats may be associated with forested areas proximal to agricultural land, data on the extent and possibility of foraging over agricultural fields is limited. The Recovery Plan states that observations of light-tagged animals and bats marked with reflective bands indicate that Indiana bats typically forage in closed to semi-open forested habitats and forest edges and that radio-tracking studies of adult males, adult females, and juveniles consistently indicate that foraging occurs preferentially in wooded areas, although type of forest varies with individual studies. The Recovery Plan states that Indiana bats hunt primarily around, not within, the canopy of trees, but they occasionally descend to sub-canopy and shrub layers. However, the Recovery Plan also states that Indiana bats have been caught, observed, and radio-tracked foraging in open habitats; analyses of habitats used by radio-tracked adult females while foraging versus those habitats available for foraging have been performed in two states.

In Illinois, floodplain forest was the most preferred habitat, followed by ponds, old fields, row crops, upland woods, and pastures. In Indiana, woodlands were used more often than areas of agriculture, low-density residential housing, and open water, and this latter group of habitats was used more than pastures, parkland, and heavily urbanized sites. Old fields and agricultural areas seemed important in both studies, but bats likely were foraging most often along forest-field edges, rather than in the interior of fields, although errors inherent in determining the position of a rapidly moving animal through telemetry made it impossible to verify this. The Recovery Plan remarks that visual observations suggest that foraging over open fields or bodies of water, more than 50 m (150 ft) from a forest edge, does occur, although less commonly than in forested sites or along edges. The Recovery Plan places feeding within agriculturally managed areas of lesser significance than forested areas and their immediate edges.

The Recovery Plan reports that in Illinois, 67 percent of the land near one colony was agricultural, and in Michigan, land cover consisted of 55 percent agricultural land. Recovery Plan discussion of available proportions of different land covers encompassing foraging habitat are limited, but the available literature suggests that foraging in agricultural lands relative to other habitats is variable with study. Sparks et al. (2005), in radio-tracking bats in Indiana, found that the number of telemetry observations of foraging was closely associated with the availability of agricultural land within the home range of the species and accounted for approximately 35 percent of observations. In contrast, Murray and Kurta (2004) radio-

tracked Indiana bats in Michigan and found that, despite the study area being over 60 percent agricultural land, the habitats frequented by 12 of the 13 monitored bats was forest land. It should be noted that exact frequencies could not be established because triangulation of individual observation points precluded exact locations in different cover types with any confidence. Menzel et al. (2005) radio-tracked bats in Illinois and found that bats foraged significantly closer to forest roads and riparian habitats than agricultural lands. A ranking of the foraging use of habitats suggested the following order of preference by bats in this study: roads> forests> riparian areas> grasslands>agricultural lands.

The Recovery Plan indicates that the prey base for the Indiana bat consists primarily of flying insects, with only a very small amount of spiders (presumably ballooning individuals) included in the diet. Four orders of insects contribute most to the diet: Coleoptera, Diptera, Lepidoptera, and Trichoptera. The Recovery Plan concludes that the diet of Indiana bats, to a large degree, may reflect availability of preferred types of insects within the foraging areas that the bats happen to be using, again suggesting that they are selective opportunists.

Given the above information, it is reasonable to conclude that Indiana bats make use of agricultural land as a source of prey and can reasonably be expected to roost in patches of fragmented forest that are adjacent to cotton and soybean fields. They are opportunistic foragers and are expected to forage over many different land covers, including agricultural land, on a broad range of insects/arthropods. A survey of insect populations in agricultural fields reveals a variety of flying, foliage and ground dwelling invertebrates comprising a large number of taxonomic groups that could provide on-field prey sources for bats foraging over these areas. However, the extent of foraging over agricultural land is expected to be less than the degree of foraging around the canopies of forested areas.

Initial screening level risk assessment results for the Indiana bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods having received the upper bound Kenaga residues from the spray application of dicamba.

Field metabolic rate kcal/day = $0.6167(5.4)^{0.862} = 2.64$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Indiana bat)

Mass of prey consumed per day = 2.64 kcal/day / (1.7 kcal/g ww X 0.87AE) = 1.78 g/day

Mass of DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet = 1.78 g/day X 102.99 mg DGA/kg-ww mammal prey X 0.001 = 0.18 mg/day

Daily dose in bat = 0.18 mg DGA/day/0.0054 = **33.95 mg/kg-bw/day**

Indiana Bat NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw } (350/5.4)^{(0.25)} = 385.88 \text{ mg/kg-bw}$
 RQ for chronic exposure for three applications, peak exposure number: $RQ = 33.95/385.88 = 0.09$.

An RQ of 0.09 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Indiana Bat.**

DCSA Assessment for Indiana bat consuming prey that had previously consumed soybean forage

Initial screening level risk assessment results for the Indiana bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods feeding on dicamba-tolerant soybean plant tissues that had the highest measured DCSA residues.

Field metabolic rate kcal/day = $0.6167(5.4)^{0.862} = 2.64$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Indiana bat)

Mass of prey consumed per day = $2.64 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.87\text{AE}) = 1.78 \text{ g/day}$

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = $1.78 \text{ g/day} \times 42.5 \text{ mg DCSA/kg-ww insect prey} \times 0.001 = 0.076 \text{ mg/day}$

Daily dose in bat = $0.076 \text{ mg DCSA /day} / 0.0054 \text{ kg} = \mathbf{14.01 \text{ mg/kg-bw/day}}$

Indiana Bat NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} (350/5.4)^{(0.25)} = \mathbf{22.70 \text{ mg/kg-bw}}$

RQ for chronic exposure: $RQ = 8.00/22.70 = \mathbf{0.62}$

An RQ of **0.62** does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Indiana Bat.**

Ozark Bat

The Ozark big-eared bat inhabits caves and cliffs that can be found in large blocks of forest to small forest tracts interspersed with open areas. Land use of surrounding areas does not appear to influence location of occupied maternity caves and hibernacula. The Recovery Plan (USFWS, 1995) indicates that the prey base for the Ozark bat consists primarily of lepidopterans and that edge habitat between forested and open areas is the preferred foraging area. Open areas allow for easy foraging because bats are not obstructed by branches while pursuing prey and are able to discriminate insects at greater distances. Based on this information, the Ozark bat cannot be precluded from foraging on agricultural fields.

Initial screening level risk assessment results for the Ozark bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects having received the upper bound Kenaga residues from the spray application of dicamba.

Field metabolic rate kcal/day = $0.6167(7.0)^{0.862} = 3.30$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Ozark bat)

Mass of prey consumed per day = $3.30 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.87\text{AE}) = 2.23 \text{ g/day}$

Mass of DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet = 2.23 g/day X 102.99 mg DGA/kg-ww mammal prey X 0.001 = 0.23 mg/day

Daily dose in bat = 0.23 mg DGA/day/0.007 = **32.81 mg/kg-bw/day**

Ozark Bat NOAEL mg/kg-bw/day = 136 mg/kg-bw (350/7.0)^(0.25) = **361.64 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: $RQ = 32.81/361.64 = 0.09$.

An RQ of 0.09 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Ozark Bat.**

DCSA Assessment for Ozark Bat consuming prey that had previously consumed soybean forage

Initial screening level risk assessment results for the Ozark bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods feeding on dicamba-tolerant soybean plant tissues that had the highest measured DCSA residues.

Field metabolic rate kcal/day = $0.6167(7.0)^{0.862} = 3.30$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Ozark bat)

Mass of prey consumed per day = 3.30 kcal/day / (1.7 kcal/g ww X 0.87AE) = 2.23 g/day

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 2.23 g/day X 42.5 mg DCSA/kg-ww mammal prey X 0.001 = 0.095 mg/day

Daily dose in bat = 0.095 mg DCSA/day/0.007 = **13.54 mg/kg-bw/day**

Ozark Bat NOAEL mg/kg-bw/day = 8 mg/kg-bw (350/7.0)^(0.25) = **21.27 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: $RQ = 13.54/21.27 = 0.64$

An RQ of **0.64** does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Ozark Bat.**

Louisiana Black Bear

The Louisiana black bear inhabits bottomland hardwood forest communities, brackish and freshwater marshes, salt domes, wooded spoil levees along canals and bayous, and agricultural fields. Remoteness is an important spatial feature based on forest tract size and presence of roads (US FWS Recovery Plan, 1995). The Recovery Plan further describes black bears as opportunistic omnivores with their diet being

determined by food availability and season. Diet includes: grasses, sedges, invertebrates (primarily beetles, grubs, and insects), carrion, garbage, and agricultural crops (including grain from soybean and corn, but consumption of cotton plant parts is unlikely). Personal communication with Deborah Fuller of the USFWS (Fuller 2015) indicates that, by analogy to North Carolina black bears, Louisiana black bears can be expected to feed on cotton boll pests as well as grubs in the fields. The other potential attractive food source in these fields would be soybean grain. On the basis of this information and the expectation that the modeled residues on arthropods (111.14 mg dicamba DGA/kg) would be much higher than modeled residues in soybean pods or seeds (17.74 mg dicamba DGA/kg), a refinement of the screening level assessment for the bear was initiated to reflect the conservative assumptions of exclusive consumption of exposed terrestrial invertebrates having received the upper bound Kenaga residues from the dicamba application in a treated field:

Field metabolic rate kcal/day = $0.800(92000)^{0.813}$ = 8682.59 kcal/day (USEPA 1993, body weight reflects screening assumption for the Louisiana black bear)

Mass of prey consumed per day = 8682.59 kcal/day / (1.7 kcal/g ww X 0.87 AE) = 5870.58 g/day

Mass of DGA in terrestrial invertebrate diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet = 5870.58 g/day X 102.99 mg DGA/kg-ww mammal prey X 0.001 = 604.61 mg/day

Daily dose in bear = 604.61 mg DGA/day/92 kg = **6.57 mg/kg-bw/day**

Louisiana Black Bear NOAEL mg/kg-bw/day = 136 mg/kg-bw $(350/92000)^{(0.25)}$ = **33.78 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: $RQ = 6.57/33.78 = 0.19$.

A chronic RQ of 0.19 does not exceed the chronic LOC of 1.0. **Consequently a “no effect” determination is concluded for the Louisiana black bear.**

DCSA Assessment for Louisiana Black Bear consuming prey that had previously consumed soybean forage

The screening level risk assessment found that DCSA residues in arthropods in cotton fields (based on the empirical residues in broadleaf plant tissues and extrapolated via the Kenaga nomogram to residues in arthropods) would not exceed any chronic levels of concern for mammals. The analysis of the Louisiana Black Bear’s recovery plan described above indicates that in soybean fields, the attractive food source in these fields would be soybean grain (seeds). On the basis of this information, the refinement of the soybean screening level assessment was initiated to reflect the conservative assumption of exclusive consumption of exposed soybean grain containing the maximum measured DCSA residues.

Field metabolic rate kcal/day = $0.800(92000)^{0.813}$ = 8682.59 kcal/day (USEPA 1993, body weight reflects screening assumption for the Louisiana black bear)

Mass of soybean seeds consumed per day = 8682.59 kcal/day / (0.51 kcal/g ww X 0.85 AE0.43) = 20029.0 g/day

Mass of DCSA in seed diet 0.440 mg/kg-ww (conservative assumption using the maximum value from empirical data for soybean seeds)

Mass of DCSA in daily diet = 20029 g/day X 0.44 mg DCSA/kg-ww mammal prey X 0.001 = 8.88 mg/day

Daily dose in bear = 8.8 mg DCSA/day/92 kg = **0.10 mg/kg-bw/day**

Louisiana Black Bear NOAEL mg/kg-bw/day = 8 mg/kg-bw (350/92000)^(0.25) = **1.99 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: RQ = 0.10/1.99 = **0.05**

A chronic RQ of **0.05** does not exceed the chronic LOC of 1.0. **Consequently a “no effect” determination is concluded for the Louisiana black bear.**

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Appendix 1

Threatened and Endangered Species in Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin.

Animals

1. Acornshell, southern (*Epioblasma othcaloogensis*)
2. Amphipod, Illinois cave (*Gammarus acherondytes*)
3. Bat, gray (*Myotis grisescens*)
4. Bat, Indiana (*Myotis sodalis*)
5. Bat, Ozark Big-Eared (*Corynorhinus (=plecotus) townsendii ingens*)
6. Bean, Cumberland (pearlymussel) Populations (*Villosa trabalis*)
7. Bean, purple (*Villosa perpurpurea*)
8. Bean, rayed (*Villosa fabalis*)
9. Bear, Louisiana Black (*Ursus americanus luteolus*)
10. Beetle, American Burying (*Nicrophorus americanus*)
11. Blossom, green (pearlymussel) (*Epioblasma torulosa gubernaculum*)
12. Blossom, tubercled (pearlymussel) (*Epioblasma torulosa torulosa*)
13. Blossom, turgid (pearlymussel) (*Epioblasma turgidula*)
14. Blossom, yellow (pearlymussel) (*Epioblasma florentina florentina*)
15. Butterfly, Karner blue (*Lycaeides melissa samuelis*)
16. Butterfly, Mitchell's satyr (*Neonympha mitchellii mitchellii*)
17. Catspaw, white (pearlymussel) (*Epioblasma obliquata perobliqua*)
18. Cavefish, Ozark (*Amblyopsis rosae*)
19. Cavesnail, Tumbling Creek (*Antrobia culveri*)
20. Chicken, Lesser-Prairie (*Tympanuchus pallidicinctus*)
21. Chub, slender (*Erimystax cahni*)
22. Chub, spotfin (*Erimonax monachus*)
23. Clubshell (*Pleurobema clava*)
24. Clubshell, black (*Pleurobema curtum*)
25. Clubshell, ovate (*Pleurobema perovatum*)
26. Clubshell, southern (*Pleurobema decisum*)
27. Combshell, Cumberlandian (*Epioblasma brevidens*)
28. Combshell, southern (*Epioblasma penita*)
29. Combshell, upland (*Epioblasma metastriata*)
30. Crane, Mississippi Sandhill (*Grus canadensis pulla*)
31. Crane, Whooping (*Grus americana*)
32. Crayfish, cave (*Cambarus aculabrum*)
33. Crayfish, cave (*Cambarus zophonastes*)
34. Crayfish, Nashville (*Orconectes shoupi*)
35. Dace, blackside (*Phoxinus cumberlandensis*)
36. Dace, Laurel (*Chrosomus saylora*)
37. Darter, amber (*Percina antesella*)
38. Darter, bayou (*Etheostoma rubrum*)
39. Darter, bluemask (=jewel) (*Etheostoma sp.*)
40. Darter, boulder (*Etheostoma wapiti*)
41. Darter, Cumberland (*Etheostoma susanae*)
42. Darter, duskytail (*Etheostoma percnurum*)

43. Darter, leopard (*Percina pantherina*)
44. Darter, Niangua (*Etheostoma nianguae*)
45. Darter, slackwater (*Etheostoma boschungii*)
46. Darter, snail Entire (*Percina tanasi*)
47. Darter, yellowcheek (*Etheostoma moorei*)
48. Dragonfly, Hine's emerald (*Somatochlora hineana*)
49. Elktoe, Appalachian (*Alasmidonta raveneliana*)
50. Elktoe, Cumberland (*Alasmidonta atropurpurea*)
51. Fanshell (*Cyprogenia stegaria*)
52. Fatmucket, Arkansas (*Lampsilis powellii*)
53. Ferret, black-footed (*Mustela nigripes*)
54. Frog, dusky gopher (*Rana sevosia*)
55. Heelsplitter, Alabama (=inflated) (*Potamilus inflatus*)
56. Hellbender, Ozark (*Cryptobranchus alleganiensis bishopi*)
57. Higgins eye (pearlymussel) (*Lampsilis higginsii*)
58. Kidneyshell, fluted (*Ptychobranhus subtentum*)
59. Kidneyshell, triangular (*Ptychobranhus greenii*)
60. Lampmussel, Alabama (*Lampsilis virescens*)
61. Lilliput, pale (pearlymussel) (*Toxolasma cylindrellus*)
62. Logperch, Conasauga (*Percina jenkinsi*)
63. Lynx, Canada (*Lynx canadensis*)
64. Madtom, chunky (*Noturus crypticus*)
65. Madtom, Neosho Entire (*Noturus placidus*)
66. Madtom, pygmy (*Noturus stanauli*)
67. Madtom, Scioto (*Noturus trautmani*)
68. Madtom, smoky (*Noturus baileyi*)
69. Madtom, yellowfin (*Noturus flavipinnis*)
70. Manatee, West Indian (*Trichechus manatus*)
71. Mapleleaf, winged (*Quadrula fragosa*)
72. Marstonia, royal (snail) (*Pyrgulopsis ogmorhapha*)
73. Moccasinshell, Alabama (*Medionidus acutissimus*)
74. Moccasinshell, Coosa (*Medionidus parvulus*)
75. Monkeyface, Appalachian (pearlymussel) (*Quadrula sparsa*)
76. Monkeyface, Cumberland (pearlymussel) (*Quadrula intermedia*)
77. Mucket, Neosho (*Lampsilis rafinesqueana*)
78. Mucket, orangenacre (*Lampsilis perovalis*)
79. Mucket, pink (pearlymussel) Entire (*Lampsilis abrupta*)
80. Mussel, oyster (*Epioblasma capsaeformis*)
81. Mussel, scaleshell (*Leptodea leptodon*)
82. Mussel, sheepnose (*Plethobasus cyphus*)
83. Mussel, snuffbox (*Epioblasma triquetra*)
84. Pearlshell, Louisiana (*Margaritifera hembeli*)
85. Pearlymussel, birdwing (*Lemiox rimosus*)
86. Pearlymussel, cracking (*Hemistena lata*)
87. Pearlymussel, Curtis (*Epioblasma florentina curtisii*)
88. Pearlymussel, dromedary (*Dromus dromas*)
89. Pearlymussel, littlewing (*Pegias fabula*)
90. Pearlymussel, Slabside (*Pleuonaia dolabelloides*)
91. Pigtoe, Cumberland (*Pleurobema gibberum*)
92. Pigtoe, finereyed (*Fusconaia cuneolus*)
93. Pigtoe, flat (*Pleurobema marshalli*)

94. Pigtoe, Georgia (*Pleurobema hanleyianum*)
95. Pigtoe, rough (*Pleurobema plenum*)
96. Pigtoe, shiny (*Fusconaia cor*)
97. Pigtoe, southern (*Pleurobema georgianum*)
98. Pimpleback, orangefoot (pearlymussel) (*Plethobasus cooperianus*)
99. Plover, piping except Great Lakes watershed (*Charadrius melodus*)
100. Plover, piping Great Lakes watershed (*Charadrius melodus*)
101. Pocketbook, fat (*Potamilus capax*)
102. Pocketbook, Ouachita rock (*Arkansia wheeleri*)
103. Pocketbook, speckled (*Lampsilis streckeri*)
104. Purple Cat's paw (=Purple Cat's paw pearlymussel) (*Epioblasma obliquata obliquata*)
105. Rabbitsfoot (*Quadrula cylindrica cylindrica*)
106. Rabbitsfoot, rough (*Quadrula cylindrica strigillata*)
107. Riffleshell, northern (*Epioblasma torulosa rangiana*)
108. Riffleshell, tan (*Epioblasma florentina walkeri* (=E. walkeri))
109. Ring pink (mussel) (*Obovaria retusa*)
110. Riversnail, Anthony's (*Athearnia anthonyi*)
111. Sawfish, smalltooth TX, FL (*Pristis pectinata*)
112. Sculpin, grotto (*Cottus sp.*)
113. Sea turtle, green (*Chelonia mydas*)
114. Sea turtle, hawksbill (*Eretmochelys imbricata*)
115. Sea turtle, Kemp's ridley (*Lepidochelys kempii*)
116. Sea turtle, leatherback (*Dermochelys coriacea*)
117. Sea turtle, loggerhead Northwest Atlantic DPS (*Caretta caretta*)
118. Shiner, Arkansas River (*Notropis girardi*)
119. Shiner, blue (*Cyprinella caerulea*)
120. Shiner, Topeka (*Notropis topeka* (=tristis))
121. Snail, Iowa Pleistocene (*Discus macclintocki*)
122. Snail, painted snake coiled forest (*Anguispira picta*)
123. Snake, copperbelly water (*Nerodia erythrogaster neglecta*)
124. Spectaclecase (mussel) (*Cumberlandia monodonta*)
125. Spider, spruce-fir moss (*Microhexura montivaga*)
126. Squirrel, Carolina northern flying (*Glaucomys sabrinus coloratus*)
127. Stirrupshell (*Quadrula stapes*)
128. Sturgeon, gulf (*Acipenser oxyrinchus desotoi*)
129. Sturgeon, pallid (*Scaphirhynchus albus*)
130. Tern, least interior pop. (*Sterna antillarum*)
131. Tiger beetle, Salt Creek (*Cicindela nevadica lincolniana*)
132. Tortoise, gopher (*Gopherus polyphemus*)
133. Turtle, ringed map (*Graptemys oculifera*)
134. Turtle, yellow-blotched map (*Graptemys flavimaculata*)
135. Vireo, black-capped (*Vireo atricapilla*)
136. Warbler, Kirtland's (*Setophaga kirtlandii*)
137. Wartyback, white (pearlymussel) (*Plethobasus cicatricosus*)
138. Whale, finback (*Balaenoptera physalus*)
139. Whale, humpback (*Megaptera novaeangliae*)
140. Wolf, gray (*Canis lupus*)
141. Woodpecker, red-cockaded (*Picoides borealis*)

Plants

142. Aster, decurrent false (*Boltonia decurrens*)

143. Aster, Ruth's golden (*Pityopsis ruthii*)
144. Avens, spreading (*Geum radiatum*)
145. bladderpod, Missouri (*Physaria filiformis*)
146. Bladderpod, Spring Creek (*Lesquerella perforata*)
147. Bluet, Roan Mountain (*Hedysotis purpurea* var. *montana*)
148. Bush-clover, prairie (*Lespedeza leptostachya*)
149. Butterfly plant, Colorado (*Gaura neomexicana* var. *coloradensis*)
150. Chaffseed, American (*Schwalbea americana*)
151. Clover, running buffalo (*Trifolium stoloniferum*)
152. Daisy, Lakeside (*Hymenoxys herbacea*)
153. Fern, American hart's-tongue (*Asplenium scolopendrium* var. *americanum*)
154. *Geocarpon minimum* (No common name)
155. Goldenrod, Blue Ridge (*Solidago spithamea*)
156. Goldenrod, Short's (*Solidago shortii*)
157. Grass, Tennessee yellow-eyed (*Xyris tennesseensis*)
158. Ground-plum, Guthrie's (=Pyne's) (*Astragalus bibullatus*)
159. Harperella (*Ptilimnium nodosum*)
160. Iris, dwarf lake (*Iris lacustris*)
161. Ladies'-tresses, Ute (*Spiranthes diluvialis*)
162. Lichen, rock gnome (*Gymnoderma lineare*)
163. Lily, Minnesota dwarf trout (*Erythronium propullans*)
164. Locoweed, Fassett's (*Oxytropis campestris* var. *chartacea*)
165. Milkweed, Mead's (*Asclepias meadii*)
166. Monkshood, northern wild (*Aconitum noveboracense*)
167. Orchid, eastern prairie fringed (*Platanthera leucophaea*)
168. Orchid, western prairie fringed (*Platanthera praeclara*)
169. Penstemon, blowout (*Penstemon haydenii*)
170. Pitcher-plant, green (*Sarracenia oreophila*)
171. Pogonia, small whorled (*Isotria medeoloides*)
172. Pondberry (*Lindera melissifolia*)
173. Potato-bean, Price's (*Apios priceana*)
174. Prairie-clover, leafy (*Dalea foliosa*)
175. Quillwort, Louisiana (*Isoetes louisianensis*)
176. Rock-cress, Braun's (*Arabis perstellata*)
177. Rosemary, Cumberland (*Conradina verticillata*)
178. Roseroot, Leedy's (*Rhodiola integrifolia* ssp. *leedyi*)
179. Sandwort, Cumberland (*Arenaria cumberlandensis*)
180. Skullcap, large-flowered (*Scutellaria montana*)
181. Sneezeweed, Virginia (*Helenium virginicum*)
182. Spiraea, Virginia (*Spiraea virginiana*)
183. Thistle, Pitcher's (*Cirsium pitcheri*)

Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Field – Accounting for Spray Drift and Runoff Mitigation Labeling Restrictions

The spray drift (in-field buffer) and rainfast mitigations discussed in the cotton section 3 ecological risk assessment (D404823), the concurrently issued soybean addendum (D426789) and the beginning of this assessment are anticipated to restrict dicamba and DCSA residues above any threshold toxicity values to the agricultural field. Therefore, the following table describes the habitat and rationale for all listed species that were determined to not use cotton and soybean fields or resources that may overlap with the dicamba DGA uses.

Species	Habitat	Rationale	Source
Animals			
<u>Acornshell, southern (Epioblasma othcaloogensis)</u>	The southern acornshell is historically restricted to shoals in small rivers to small streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS 2000, p. 57).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2000. Recovery Plan for Mobile River Basin Aquatic Ecosystem. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Amphipod, Illinois cave (Gammarus acherondytes)</u>	The Illinois cave amphipod lives in streams primarily in the dark zone of caves in parts of the Salem Plateau of Illinois. Little is known of the biology and habitat requirements of this species although it has been collected in mainstream gravel riffles, smaller tributary streams, rimstone pools, and from streams with silt overlying bedrock. As a group, amphipods require cool water temperatures and are intolerant of wide ranges in temperature (US FWS 2002)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920.pdf

Species	Habitat	Rationale	Source
<u>Bat, gray</u> <u>(Myotis</u> <u>grisescens)</u>	Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when migrating (US FWS, 1982, pp. 6-7).	The proposed dicamba DGA uses are not expected to encompass caves or the forest/open water areas where bats forage.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf

Species	Habitat	Rationale	Source
<u>Bean, Cumberland (pearly mussel) (Villosa trabalis)</u>	Restricted typically to tributary streams of the upper reaches of the Tennessee and Cumberland Rivers. This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, <i>V. trabalis</i> is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species (US FWS 2010, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc3244.pdf
<u>Bean, purple (Villosa perpurpurea)</u>	Inhabits small headwater streams (Neves 1991) to medium-sized rivers (Gordon 1991). It is found in moderate to fast-flowing riffles with sand, gravel, and cobble substrates (Neves 1991) and rarely occurs in deep pools or slack water (Ahlstedt 1991a). It is sometimes found out of the main current adjacent to water-willow beds and under flat rocks (Ahlstedt	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
	1991a, Gordon 1991) (US FWS 2004, p. 19).		
<u>Bean, rayed</u> (<u>Villosa fabalis</u>)	The rayed bean is generally known from smaller, headwater creeks, but occurrence records exist from larger rivers (Cummings and Mayer 1992, p. 142; Parmalee and Bogan 1998, p. 244). They are usually found in or near shoal or riffle (short, shallow length of stream where the stream flows more rapidly) areas, and in the shallow, wave-washed areas of glacial lakes, including Lake Erie (West et al. 2000, p. 253). In Lake Erie, the species is generally associated with islands in the western portion of the lake. Preferred substrates typically include gravel and sand. The rayed bean is oftentimes found among vegetation (water willow (<i>Justicia americana</i>) and water milfoil (<i>Myriophyllum</i> sp.)) in and adjacent to riffles and shoals (Watters 1988b, p. 15; West et al. 2000, p. 253) (US FWS 2012, p. 8633).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS 2012 - Federal Register Determination of Endangered Status. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
<u>Blossom, green</u> (<u>pearlymussel</u>) (<u>Epioblasma</u> <u>torulosa</u> <u>gubernaculum</u>)	Cumberlandian freshwater mussels are most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. The	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060228.pdf USFWS. 2007. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc1961.pdf

Species	Habitat	Rationale	Source
	<p>mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS 1984, p. 5)</p> <p>The last known record for the green-blossom pearly mussel was a live individual collected in 1982 (US FWS 2007, p. 7).</p>		
<u>Blossom, tubercled</u> (pearlymussel) (<u>Epioblasma torulosa torulosa</u>)	Occurs only in headwater tributaries of the Tennessee River (US FWS 1985, p. 11).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850125.pdf
<u>Blossom, turgid</u> (pearlymussel) (<u>Epioblasma turgidula</u>)	The last known collection of the turgid-blossom pearly mussel was a fresh-dead specimen found in the Duck River, Tennessee, in 1965 (US FWS 2007, p. 7)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2007. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc1961.pdf
<u>Blossom, yellow</u> (pearlymussel) (<u>Epioblasma florentina florentina</u>)	The last known specimen of the yellow-blossom pearly mussel was recorded in the Little Tennessee River and Citico Creek, Tennessee in 1967 (US FWS 2007, p. 7)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2007. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc1961.pdf
<u>Butterfly, Karner blue</u> (<u>Lyciaides melissa samuelis</u>)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy (US FWS, 2003. pp.28-30)	The proposed dicamba DGA uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf

Species	Habitat	Rationale	Source
<u>Butterfly,</u> <u>Mitchell's satyr</u> <u>(Neonympha</u> <u>mitchellii</u> <u>mitchellii)</u>	Mitchell's satyr habitat is best characterized as a sedge-dominated fen community; Known habitats are all peatlands but range along a continuum from prairie/bog fen to sedge meadow/swamp. However, certain attributes at each site remain fairly constant. All historical and active habitats have a herbaceous community which is dominated by sedges, usually <i>Carex stricta</i> , with scattered deciduous and/or coniferous trees, most often <i>L. laricina</i> or <i>Juniperus virginiana</i> (red cedar) (US FWS 1998, pp. 11-12).	The proposed dicamba DGA uses are not expected to overlap with wetlands or areas with sedge communities.	USFWS 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf
<u>Catspaw, white</u> <u>(pearlymussel)</u> <u>(Epioblasma</u> <u>obliquata</u> <u>perobliquata)</u>	The white cat's paw pearly mussel is currently known to exist in only a 3-mile portion of Fish Creek in Williams County in northwest Ohio. Museum records indicate that it historically occurred in Indiana in the Wabash, White, Tippecanoe, Maumee, and St. Joseph rivers, and Ohio in the Maumee and St. Joseph Rivers and Fish Creek. It was last observed in 1999 (US FWS, 2009, p. 7). The Recovery Plan indicates that the habitat is unclear but appears to be riffle run reaches of small to moderately large rivers (US FWS, 1990, p. 16).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900125.pdf

Species	Habitat	Rationale	Source
<u>Cavefish, Ozark</u> (<u>Amblyopsis</u> <u>rosae</u>)	Cavefish occur in groundwater habitats (the Springfield Plateau Aquifer) within Boone and Burlington Formation limestones, especially in cave streams with chert rubble substrate, and occasionally in wells and sinkholes, and even in the soil phreatic zone (Poulson, 1961, 1963; USFWS, 1986). Woods and Inger (1957) suggest cavefish dispersal occurs through phreatic cave passages. Noltie and Wicks (2001) suggests that due to shale geologic confining units, Ozark cavefish are distributed in near surface and epikarst habitats (US FWS 2011).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3850.pdf
<u>Cavesnail,</u> <u>Tumbling Creek</u> (<u>Antrobia</u> <u>culveri</u>)	Troglobitic creek - Tumbling Creek ranges from 0.014 to 2.8 cubic meters per second (~ 0.5 to 100 cubic ft. per second); the mean annual flow is between 0.08 to 0.14 cubic meters per second (~ 3 to 5 cubic feet per second). The stream contains many chert pebbles which have been highly polished by natural abrasion within the cave...The land surface above the cave includes a variety of woodland and glade natural communities as well as pastures and/or	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030922a.pdf

Species	Habitat	Rationale	Source
	open fields. (US FWS 2003, p. 10).		
<u>Chub, slender</u> (<u>Erimystax</u> <u>cahni</u>)	The slender chub is restricted to the upper Tennessee River drainage in Tennessee and Virginia (US FWS 2014, p. 6)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc4357.pdf
<u>Chub, spotfin</u> (<u>Erimonax</u> <u>monachus</u>)	The species is an insectivore, feeding diurnally presumably by both sight and taste in benthic areas of slow to swift current over various substrates with little siltation. Streams may range from 15-60 m in width and, where occupied, 0.3-10.0 m in depth. Water temperature in their summer habitat usually reaches greater than 20°C, and submerged macrophytes are usually absent, occasionally common. The species has been observed associated with sand, gravel, rubble, boulder, and bedrock substrates (Jenkins and Burkhead, 1982) (US FWS 1983, p. 15).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/831121.pdf
<u>Clubshell</u> (<u>Pleurobema</u> <u>clava</u>)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf
<u>Clubshell, black</u> (<u>Pleurobema</u> <u>curtum</u>)	This species inhabits the Tombigbee River, which is a major western tributary of the Mobile Basin. It is characterized by an	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf

Species	Habitat	Rationale	Source
	increasing number of sand and gravel shoals and decreasing channel size (US FWS, 1989, p. 1)		
<u>Clubshell, ovate (Pleurobema perovatum)</u>	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 56)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Clubshell, southern (Pleurobema decisum)</u>	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 58)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Combshell, Cumberlandian (Epioblasma brevidens)</u>	This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse, sand, gravel, cobble, and boulders. It is not associated with small stream habitats and tends not to extend as far upstream in tributaries (US FWS 2004, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
<u>Combshell, southern (Epioblasma penita)</u>	This species inhabits the Tombigbee River, which is a major western tributary of the Mobile Basin. It is characterized by an increasing number of sand and gravel shoals and decreasing channel size (US FWS, 1989, p. 1)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Combshell, upland (Epioblasma metastrata)</u>	Restricted to shoals in rivers and large streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS, 2000, p. 61)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4153.pdf

Species	Habitat	Rationale	Source
<u>Crayfish, cave</u> <u>(Cambarus</u> <u>aculabrum)</u>	This species inhabits troglobitic Stream - Along the walls of pools or along stream edges. They can be found on silt, gravel, rubble and bedrock, or even hiding underneath trash, such as an old discarded boot.; Logan Cave, Bear Hollow Cave, Elm Springs, and Old Pendergrass (US FWS 2013, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2013. Five Year Recovery. http://ecos.fws.gov/docs/five_year_review/doc4153.pdf
Crayfish, Cave (<i>Cambarus zophonastes</i>)	This species inhabits troglobitic stream - muddy stream bottoms, cave stream walls, and other in-stream habitats; found in Hell Creek, Nesbitt Spring: groundwater upwelling in Town Branch... approximately 40 miles northwest of the other known sites, which are found near one another, suggesting a much wider subterranean distribution of the species. (6)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. Hell Creek Cave Crayfish 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4153.pdf
<u>Crayfish,</u> <u>Nashville</u> <u>(Orconectes</u> <u>shoupi)</u>	Much of the stream bank where this species occurs is vegetated with trees and shrubs (Bouchard 1976). The Nashville crayfish has been found in a wide range of environments including gravel and cobble runs, pools with up to 10 centimeters (cm) of settled sediment, and under slabrocks and other cover (the largest crayfish are usually under cover) (USFWS 1989). The species is	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890208.pdf

Species	Habitat	Rationale	Source
	highly photosensitive and is usually found under cover during the day (Bouchard 1976). Canopy cover appears important, as O'Bara et al. (1985) reported that all sites they sampled had canopy cover of 60 to 90 percent. The species has been found in small pools where the flow was intermittent (Stark 1986, Miller and Hartfield 1985). Gravel-cobble substrate provides good cover for juveniles (Stark 1986, Miller and Hartfield 1985). Females seek out large slabrocks when they are carrying eggs and young. These secluded places are also needed for molting (USFWS 1989).		
<u>Dace, blackside (Phoxinus cumberlandensis)</u>	This species inhabits cool, small, upland streams with moderate flows. The fish is generally associated with undercut stream banks and large rocks, and it is usually found within well-vegetated watersheds with good riparian vegetation (US FWS 1988, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/880817.pdf
<u>Dace, Laurel (Chrosomus saylori)</u>	This species has most often been collected from pools or slow runs from undercut banks or beneath slab-rock boulders, typically in first or second order, clear, cool, streams. Substrates typically consist of a mixture of	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designated Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf

Species	Habitat	Rationale	Source
	cobble, rubble, and boulders, and the streams tend to have a dense riparian zone consisting largely of mountain laural (US FWS, 2012, p. 63606)		
<u>Darter, amber</u> (<u>Percina</u> <u>antesella</u>)	This species inhabits gentle riffle areas over sand, gravel, and cobble substrates. Aquatic vegetation that develops in riffles provides habitat for feeding and cover (US FWS, 1986, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf
<u>Darter, bayou</u> (<u>Etheostoma</u> <u>rubrum</u>)	The portion of Bayou Pierre System serving as habitat for this species is a meandering stream with stable gravel riffles or sandstone exposures (US FWS, 1990, p. 3).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900710.pdf
<u>Darter, bluemask</u> (= <u>jewel</u>) (<u>Etheostoma</u> <u>sp.</u>)	This species inhabits slow to moderate current over clean sand and fine gravel at depths of 4 to 20 inches; it typically occurs just downstream of riffles or along the margins of pools and runs (US FWS, 1997, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970725.pdf
<u>Darter, boulder</u> (<u>Etheostoma</u> <u>wapiti</u>)	This species inhabits warm-water riverine environments and has been found only in moderate to fast current over boulder/slab rock substrate in water over 2 feet deep (US FWS, 1989, p. 2).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890727.pdf
<u>Darter, Cumberland</u> (<u>Etheostoma</u> <u>susanae</u>)	This species inhabits pools or shallow runs of low to moderate gradient sections of streams with stable	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designated Critical Habitat.

Species	Habitat	Rationale	Source
	sand, silt, or sand-covered bedrock substrates (US FWS, 2012, p. 63605).		http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>Darter, duskytail (Etheostoma percunrum)</u>	This species inhabits rocky areas in gently flowing shallow pools and runs in large creeks and moderately large rivers in the Tennessee and Cumberland River Systems (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/duskytaildarter_RP.pdf
<u>Darter, leopard (Percina pantherina)</u>	The leopard darter typically inhabits pools having predominantly rubble and boulder substrates with current velocities less than 48 centimeters/second (Jones 1984, Lechner et al. 1987). Preferred water depths are generally 20-102 cm (Jones et al. 1984; James 1989), although joint Service/U.S. Forest Service surveys over the past 10 years have observed leopard darters from depths over 4.0 meters; large to intermediate streams having relatively steep grade (US FWS 2012, p. 12).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4107.2.12%20with%20signatures.pdf
<u>Darter, Niangua (Etheostoma nianguae)</u>	Medium sized streams of the Salem Plateau, of order 3, 4, and 5, having gradients of 3 to 21 feet/mile, elevation of stream bed =550-1050 ft, moderately clear upland creeks draining hilly topography underlain by bedrocks consisting principally of chert-	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890717.pdf

Species	Habitat	Rationale	Source
	bearing dolomites (US FWS 1989, pp. 9-10).		
<u>Darter, slackwater (Etheostoma boschungii)</u>	Nonbreeding habitat is small to moderately large streams. The current is usually slow, and under normal conditions, the flow ranges from still to 0.34 m/sec. In small streams, the darters show no position preference; however, in large streams they seem to confine themselves to near the banks or to undercuts in the banks. They also occur on gravel infiltrated with silt, on silt and mud, or in a combination of these. The breeding habitat is seepage water in open fields and woods (US FWS, 1984, pp. 7-8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840308.pdf
<u>Darter, snail (Percina tanasi)</u>	This species occupies seven of nine tributaries of the upper Tennessee River in Alabama, Georgia and Tennessee (US FWS, 2013, p. 10).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4136.pdf
<u>Darter, yellowcheek (Etheostoma moorei)</u>	Devil's, Middle, South, and Archey forks of the Little Red River in Cleburne, Searcy, Stone, and Van Buren Counties... primarily within the Boston Mountains subdivision of the Ozark Plateau. Inhabits high-gradient headwater	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf

Species	Habitat	Rationale	Source
	tributaries with clear water; permanent flow; moderate to strong riffles; and gravel, cobble, and boulder substrates (Robison and Buchanan 1988, p. 429) (US FWS 2012, p. 63605).		
<u>Dragonfly,</u> <u>Hine's emerald</u> <u>(Somatochlora</u> <u>hineana)</u>	<p>The hine's emerald dragonfly occupies grass marshes and sedge meadows fed primarily by water from a mineral source or fens. Two important characteristics of the habitat appear to be groundwater-fed, shallow water slowly flowing through vegetation, and underlying dolomitic or limestone bedrock. Parts of the aquatic channels are typically covered by vegetation such as cattails or sedges. Soils can range from organic muck to mineral soils like marl. Two other important components are areas of open vegetation for foraging and forests, trees or shrubs that provide shaded areas for perching or roosting. Nearby adjacent forests may be deciduous (Illinois) or conifer (Wisconsin and Michigan).</p> <p>Larvae are usually found in small flowing streamlets within cattail marshes, sedge meadows, and</p>	The proposed dicamba DGA uses are not expected to overlap with grass marshes, sedge meadows, forested areas, or other habitat where the Hine's emerald dragonfly is expected to be found.	USFWS. 2001. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/010927.pdf

Species	Habitat	Rationale	Source
	<p>hummocks. Places with silt, leaf litter, and decaying grasses as a substrate are often used (US FWS, 2001, p. 15-16.).</p> <p>Critical Habitat of 26,531 acres have been designated in Michigan, Illinois, Wisconsin, and Missouri. Almost half of this is Mackinac County, MI.</p>		
<u>Elktoe, Appalachian (Alasmidonta raveneliana)</u>	<p>This species has been reported from relatively shallow medium-sized creeks and rivers with cool, well-oxygenated, and moderate- to fast-flowing water. It has been observed in gravelly substrata, often mixed with cobble and boulders; in cracks in bedrock; and occasionally in relatively silt-free, coarse, sandy substrata (US FWS, 1996, Executive Summary).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960826.pdf</p>
<u>Elktoe, Cumberland (Alasmidonta atropurpurea)</u>	<p>This species inhabits medium-sized rivers and may extend into headwater streams where it is often the only mussel present (Gordon and Layzer 1989, Gordon 1991). Gordon and Layzer (1989) reported that the species appears to be most abundant in flats, which were described as shallow pool areas lacking the bottom contour development of typical pools, with sand and scattered</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf</p>

Species	Habitat	Rationale	Source
	cobble/boulder material, relatively shallow depths, and slow (almost imperceptible) currents. They also report the species from swifter currents and in areas with mud, sand, and gravel substrates (US FWS, 2004, p. 18).		
<u>Fanshell (Cyprogenia stegaria)</u>	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf
<u>fatmucket, Arkansas (Lampsilis powellii)</u>	Four microhabitat types that include: 1) long pools with cobble and rock as primary substrate types, 2) backwater areas downstream of peninsulas or islands covered with water willow (<i>Justicia americana</i>) and with cobble and sand as the dominant substrate, 3) slow moving pools upstream from water willow islands with sand, gravel, and cobble substrate, and 4) overflow, secondary channel pools, and tributary confluence areas with sand, cobble, and some rock substrate (US FWS 2013, p. 5)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
<u>Ferret, black-footed (Mustela nigripes)</u>	The black-footed ferret relies on prairie dog colonies for both food and shelter.	The proposed dicamba DGA uses are not expected to overlap with prairie dog colonies.	USFWS. 2008. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2364.pdf
<u>Frog, dusky gopher (Rana sevosa)</u>	Upland sandy habitats (forest dominated by longleaf pine (Pinus	The proposed dicamba DGA uses are not expected to overlap with	USFWS. 2011. Federal Register Notice: Designation of Critical Habitat.

Species	Habitat	Rationale	Source
	palustris)), wetlands (ephemeral ponds) embedded within the forest ...Adults and subadults spend the majority of their lives underground (in gopher tortoise (<i>Gopherus polyphemus</i>) and mammal burrows and holes under old stumps)...During the breeding season, Mississippi gopher frogs leave their subterranean retreats in the uplands and migrate to their breeding sites during rains associated with passing cold fronts. Breeding sites are ephemeral (seasonally flooded) isolated ponds (not connected to other water bodies) located in the uplands. Both forested uplands and isolated wetlands (see further discussion of isolated wetlands in “Sites for Breeding, Reproduction, and Rearing of Offspring” section) are needed to provide space for individual and population growth and normal behavior. (US FWS 2011, p. 59777-59778)	forested areas, wetlands, or ephemeral isolated ponds.	http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf

Species	Habitat	Rationale	Source
<u>Heelsplitter,</u> <u>Alabama</u> <u>(=inflated)</u> <u>(Potamilus</u> <u>inflatus)</u>	This species prefers a soft, stable substrate in slow to moderate currents. It has been found in sand, mud, silt and sandy-gravel, but not in large or armored gravel (US FWS, 1993, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930413.pdf
<u>Hellbender,</u> <u>Ozark</u> <u>(Cryptobranchu</u> <u>s alleganiensis</u> <u>bishopi)</u>	Cool, clear streams and rivers with many large rocks...small hellbenders hide beneath large rocks and also small stones in gravel beds. Adults spend most of their life under large, flat rocks; typically limestone or dolomite [rocks], and in moderate to deep (less than 3 to 9.8 feet (less than 1 to 3 meters)), rocky, fast-flowing streams in the Ozark Plateau (Johnson 2000, p. 42; Fobes and Wilkinson 1995, pp. 5–7). In spring-fed streams, Ozark Hellbenders will often concentrate downstream of the spring, where there is little water temperature change throughout the year (US FWS 2011, p. 61956).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2011. Federal Register Notice: Listing Document. http://www.gpo.gov/fdsys/pkg/FR-2011-10-06/pdf/2011-25690.pdf
<u>Higgins eye</u> <u>(pearlymussel)</u> <u>(Lampsilis</u> <u>higginsii)</u>	The higgins eye pearlymussel is characterized as an inhabitant of large rivers with loose substrates and low velocities. Many of the largest populations are in the Mississippi River, and all are in its upper drainage (US FWS, 2004, p. 7-8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040714.pdf

Species	Habitat	Rationale	Source
<u>Kidneyshell, fluted</u> (<u>Ptychobranhus subtentum</u>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
<u>Kidneyshell, triangular</u> (<u>Ptychobranhus greenii</u>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 60)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf
<u>Lampmussel, Alabama</u> (<u>Lampsilis virescens</u>)	This species inhabits sand and gravel substrates in small to medium sized streams (US FWS, 1985, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf
<u>Lilliput, pale</u> (<u>pearlymussel</u>) (<u>Toxolasma cylindrellus</u>)	This species is observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840822.pdf
<u>Logperch, Conasauga</u> (<u>Percina jenkinsi</u>)	This species has been collected in deep shuts and flowing pools with clear, clean gravel and mixed rubble substrates in areas with moderate to swift currents (US FWS, 1986, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf

Species	Habitat	Rationale	Source
Lynx, Canada (<i>Lynx canadensis</i>)	PCE: Boreal forest landscapes with large populations of snowshoe hares. Distribution and abundance of prey and microclimate influence movement, hunting behavior, and den and resting site locations. Areas with dense cover.	The proposed dicamba DGA uses are not expected to overlap with boreal forests. The lynx's prey, snowshoe hares, also do not overlap with the proposed dicamba DGA use sites.	USFWS. 2014. Federal Register Notice: Designation of Critical Habitat http://www.gpo.gov/fdsys/pkg/FR-2014-09-12/pdf/2014-21013.pdf
<u>Madtom</u> , <u>chucky</u> Entire (<i>Noturus crypticus</i>)	This species has been found in stream runs with slow to moderate current over pea gravel, cobble, or slab-rock boulder substrates (US FWS, 2012, p. 63606)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>Madtom</u> , <u>Neosho</u> (<i>Noturus placidus</i>)	Benthic species inhabits shallow gravel substrates. The species remains primarily inactive and hidden in bottom substrate during the day, and comes out at night to forage for aquatic invertebrates (Moss 1981). The majority of Neosho madtom collections are from areas with gravel substrates, primarily gravel in the size range of 0.5 to 2.5 inches (12 – 64 mm) in diameter. Most collections are made in the Spring and Neosho Rivers in shallow water, generally less than three feet deep (<1 m). Within these systems, no significant differences in madtom preferences for depth, velocity, and substrate size were found but gravel riffles with currents of one to four	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4140.pdf

Species	Habitat	Rationale	Source
	feet per second (<1.25 m/sec.) are preferred by adults (Moss 1981; Fuselier and Edds 1994; Wildhaber et al. 2000a) (US FWS 2013, pp. 6).		
<u>Madtom, pygmy (Noturus stanauli)</u>	This species inhabits shallow shoals, where the current is moderate to strong and where there is pea-sized gravel or fine sand substrates, in moderately large rivers of the Tennessee River system (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940927a.pdf
<u>Madtom, Scioto (Noturus trautmani)</u>	Only 18 individuals have ever been collected, all found along one stretch of Big Darby Creek in Ohio (US FWS, 2009, p. 4). The scioto madtom prefers stream riffles of moderate current over gravel bottoms with high quality water that is free of suspended sediments. The riffle habitat where the 18 individual were collected was comprised of glacial cobble, gravel, sand, and silt substrate with some large boulders (US FWS, 2009, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3057.pdf
<u>Madtom, smoky (Noturus baileyi)</u>	This species is restricted to Citico Creek, primarily within the Cherokee National Forest, Monroe County, Tennessee (US FWS, 1985,p. 1)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060313b.pdf

Species	Habitat	Rationale	Source
<u>Madtom</u> , <u>yellowfin</u> (<u>Noturus</u> <u>flavipinnis</u>)	This species prefers pool habitats beneath cobble and small boulder substrates (Miller 2011). The strongest habitat models identified preferred pools for yellowfin madtoms as greater than 40 meters in length with gravel being the main substrate beneath cover rocks (Miller 2011). (US FWS, 2012, p. 16).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4146.pdf
<u>Manatee</u> , <u>West Indian</u> (<u>Trichechus</u> <u>manatus</u>)	This species lives in freshwater, brackish and marine habitats (US FWS, 2001, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2001. Recovery Plan- Third Revision. http://ecos.fws.gov/docs/recovery_plan/011030.pdf
<u>Mapleleaf</u> , <u>winged</u> (<u>Quadrula</u> <u>fragosa</u>)	The general habitat is poorly known, although it has been characterized as a large stream species. It has been collected on mud, mud-covered gravel, and gravel substrates. In its current location in the St. Croix River, it occurs in riffles with clean gravel, sand, or rubbles substrates and fast current. It was not found in a natural impoundment of the river (US FWS, 1997, p. 5-6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970625.pdf
<u>Marstonia</u> , <u>royal</u> (<u>snail</u>) (<u>Pyrgulopsis</u> <u>ogmorhaphes</u>)	This species is found in Blue Spring, which is in the water supply for the town of Jasper, Tennessee, and downstream to the State Highway 64 bridge (US FWS, 1995, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950811.pdf

Species	Habitat	Rationale	Source
<u>Moccasinshell, Alabama (Medionidus acutissimus)</u>	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 51)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Moccasinshell, Coosa (Medionidus parvulus)</u>	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 52)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Monkeyface, Appalachian (pearlymussel) (Quadrula sparsa)</u>	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709.pdf
<u>Monkeyface, Cumberland (pearlymussel) (Quadrula intermedia)</u>	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709b.pdf
<u>Mucket, Neosho (Lampsilis rafinesqueana)</u>	The Neosho mucket is associated with shallow riffles and runs comprising gravel substrate and moderate to swift currents. The species is most often found in areas with swift current, but in	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Proposed Listing Document. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf

Species	Habitat	Rationale	Source
	Shoal Creek and the Illinois River it prefers near-shore areas or areas out of the main current (Oesch 1984, p. 221; Obermeyer 2000, pp. 15–16) (US FWS 2012, p. 63443).		
<u>Mucket, orangenacre (Lampsilis perovalis)</u>	Currently restricted to high quality stream and small river habitat, the species is found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS 2000, p. 55)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Mucket, pink (pearlymussel) (Lampsilis abrupta)</u>	<p>The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10).</p> <p>The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the water is flowing (US FWS, 1985, p. 10).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf
<u>Mussel, oyster (Epioblasma capsaeformis)</u>	This species is generally adapted to live in the gravel shoals of free-flowing rivers and streams (US FWS, 2004, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
<u>Mussel, scaleshell (Leptodea leptodon)</u>	The scaleshell habitat is composed of riffles and runs in medium to large rivers with low to medium gradients and slow to moderate velocity of current. It inhabits a variety of substrates from gravel to mud, but riffles are primarily stable (US FWS, 2010, p.18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/100407_v2.pdf
<u>Mussel, sheepsnose (Plethobasus cyphus)</u>	The sheepsnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepsnose may also have mud, cobble, and boulders. Sheepsnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
<u>Mussel, snuffbox (Epioblasma triquetra)</u>	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Federal Register Notice: Listing. http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27413.pdf#page=2 USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf

Species	Habitat	Rationale	Source
<u>Pearlshell</u> , <u>Louisiana</u> (<u>Margaritifera</u> <u>hembeli</u>)	Specific habitat requirements are not known. This species apparently requires a free-flowing stream (US FWS, 1990, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/901203.pdf
<u>Pearlymussel</u> , <u>birdwing</u> (<u>Lemiox</u> <u>rimosus</u>)	This species is most often observed in clean fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. It is usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060206a.pdf
<u>Pearlymussel</u> , <u>cracking</u> (<u>Hemistena</u> <u>lata</u>)	The cracking pearlymussel has undergone a substantial range reduction. It was historically distributed in the Ohio, Cumberland, and Tennessee River systems. The species has been extirpated throughout much of its range. It was last collected from Mussel Shoals, an 85 km reach of the Tennessee River in Alabama, prior to 1925 and is presumed to be extirpated from the shoal. It is presently known to survive at only a few shoals in the Clinch and Powell Rivers in Tennessee and Virginia, and it has likely been reduced to only three viable populations in these systems. The species possibly survives in the Green River, Kentucky,	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F01X.html

Species	Habitat	Rationale	Source
	and below Pickwick Reservoir in the Tennessee River, Tennessee as well		
<u>Pearlymussel, Curtis</u> (<u>Epioblasma florentina curtisii</u>)	The Curtis' pearlymussel has not been seen alive in over a decade. Limited to stream segments that are transitional between headwater and lowland streams reaches - shallow stable riffles (US FWS 2010, p. 3, 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
<u>Pearlymussel, dromedary</u> (<u>Dromus dromas</u>)	This species is most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
<u>Pearlymussel, littlewing</u> (<u>Pegias fabula</u>)	This species inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins (US FWS, 1989, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890922.pdf
<u>Pearlymussel, Slabside</u> (<u>Pleuroaia dolabelloides</u>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf

Species	Habitat	Rationale	Source
	finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)		
<u>Pigtoe, Cumberland (Pleurobema gibberum)</u>	This species inhabits medium-sized rivers with fast-flowing water in areas with predominately gravel, sand and cobble substratum (US FWS, 1992, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920813.pdf
<u>Pigtoe, finereyed (Fusconaia cuneolus)</u>	This species is typically a riffle species that inhabits ford and shoal areas in free-flowing streams of moderate gradient (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/fine%20rayed%20recov%20plan.pdf
<u>Pigtoe, flat (Pleurobema marshalli)</u>	Habitat is the Tombigbee River, characterized by an increasing number of sand and gravel shoals and decreasing channel size in the upper portions (US FWS, 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Pigtoe, Georgia (Pleurobema hanleyianum)</u>	This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. It also requires a host fish, which is currently unknown (US FWS, 2013, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Draft Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Hartfield%20and%20Powell%202013%20Draft%20Three%20Mollusks%20RP%20062813.pdf
<u>Pigtoe, rough (Pleurobema plenum)</u>	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf

Species	Habitat	Rationale	Source
	in sand and gravel substrates (US FWS, 1984, p. 8).		
<u>Pigtoe, shiny Entire</u> (<u>Fusconaia cor</u>)	This species is typically a riffle species, found along fords and shoals of clear, moderate to fast-flowing streams and rivers with stable substrate. It does not inhabit deep pools or impounded areas. This species is usually found well-buried in the substrate during most of the year and is more readily visible in early summer (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709d.pdf
<u>Pigtoe, southern</u> (<u>Pleurobema georgianum</u>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 59)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Pimpleback, orangefoot</u> (<u>pearlymussel</u>) (<u>Plethobasus cooperianus</u>)	The 1984 Recovery Plan indicated that the orange-foot pimpleback was known from the Tennessee, Cumberland, and lower Ohio Rivers (US FWS, 1984, p. 2). The habitat is described as medium to large rivers in sand and gravel substrates. In the Ohio River it was collected from 15-29 feet depths, but may have lived in shallower riffles (US FWS, 1984, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840930b.pdf

Species	Habitat	Rationale	Source
<u>Plover, piping except Great Lakes watershed (Charadrius melodus)</u>	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation. At inland lakes, they use barren to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).	The proposed dicamba DGA uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf
<u>Plover, piping Great Lakes watershed (Charadrius melodus)</u>	The breeding habitat of the Great Lakes DPS of the piping plover is well defined by the Critical Habitat designation. Critical Habitat for this DPS consists of approximately 200 miles of Great Lakes shoreline (extending 1640 ft inland) in 26 counties in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. Additional Critical Habitat for wintering populations of this DPS are in the southeastern United States and other areas that are outside the scope of this analysis	The proposed dicamba DGA uses are not expected to overlap with sparsely vegetated sandy shorelines or islands of the Great Lakes.	USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3009.pdf USFWS. 2000. Federal Register Notice http://ecos.fws.gov/docs/federal_register/fr3648.pdf

Species	Habitat	Rationale	Source
	(USFWS, 2000; USFWS, 2009, p.2).		
<u>Pocketbook, fat</u> <u>(Potamilus</u> <u>capax)</u>	The fat pocketbook is a large river species requiring flowing water and a stable substrate, which can vary widely but is most likely a mixture of sand, silt and clay. It occurs in water from a few inches deep to at least 8 feet. Habitat includes drainage ditches. (US FWS, 1989, p. 6). Populations have been found in larger rivers in the Ohio River system, and it may occur as deep as 20 feet (US FWS, 2012, p. 7-8). It can also tolerate periods of high suspended sediments (US FWS, 2012, p. 11).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf
<u>Pocketbook,</u> <u>Ouachita rock</u> <u>(Arkansia</u> <u>wheeleri)</u>	This species inhabits pools, backwaters, and side channels of rivers and large creeks in or near the southern slope of the Ouachita Uplift. This species occupies stable substrates containing gravel, sand, and other materials (US FWS, 2004. Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040602.pdf

Species	Habitat	Rationale	Source
<u>Pocketbook speckled (Lampsilis streckeri)</u>	Specific habitat requirements are not known. The species is found in coarse to muddy sand in depths up to 0.4 meters (1.3 feet) with a constant flow of water. The occurrence in areas of constant water flow suggests a requirement for well-oxygenated conditions (US FWS 1992, p. 3).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920102.pdf
<u>Purple Cat's paw (=Purple Cat's paw pearlymussel) (Epioblasma obliquata obliquata)</u>	Inhabits boulder to sandy substrates in large rivers of the Ohio River basin (US FWS 1992, Executive summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920310.pdf
<u>Rabbitsfoot (Quadrula cylindrica cylindrica)</u>	Primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity. They have been reported in deep water runs up to 12 feet depth. "Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf
<u>Rabbitsfoot, rough (Quadrula cylindrica strigillata)</u>	Inhabits medium-sized to large rivers in moderate to swift current but often exists in areas close to, but not in, the swiftest current (Gordon 1991). It is reported to live in silt, sand, gravel, or cobble in eddies at the edge of midstream currents and may be associated with	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	FWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
	macrophyte beds (Yeager and Neves 1986, Gordon 1991). The rough rabbitsfoot seldom burrows; it generally lies on its side on the stream bottom (Neves, pers. comm., 2003) (US FWS 2004, p. 19).		
<u>Riffleshell, northern (Epioblasma torulosa rangiana)</u>	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf
<u>Riffleshell, tan (Epioblasma florentina walkeri (=E. walkeri))</u>	This species inhabits streams described as shallow and turbid with numerous riffles and substrate consisting of loose rocks and gravel bars with an abundance of water willow (US FWS, 1984, P, 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/tan%20riffleshell%20rp.pdf
<u>Ring pink (mussel) (Obovaria retusa)</u>	This species inhabits gravel and sandy substrates in large rivers of the Ohio River basin (US FWS, 1991).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910325.pdf

Species	Habitat	Rationale	Source
<u>Riversnail, Anthony's (Athearnia anthonyi)</u>	This species is typically found in large streams on large submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water (US FWS, 1997).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970813.pdf
<u>Sawfish, smalltooth (Pristis pectinata)</u>	Smalltooth sawfish are tropical marine and estuarine fish that have the northwestern terminus of their Atlantic range in the waters of the eastern United States. In the United States, smalltooth sawfish are generally a shallow water fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. (US FWS NMFS, NOAA 2001, p. 19416)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS, NOAA. 2001. Federal Register Notice: Proposed Endangered Status for a DPS of Smalltooth Sawfish. http://ecos.fws.gov/docs/federal_register/fr3741.pdf
<u>Sea turtle, green (Chelonia mydas)</u>	Green turtles are primarily restricted to tropical and subtropical waters. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found from Massachusetts to Texas and in the U.S. Virgin Islands and Puerto Rico...Seagrasses are the principal dietary component of juvenile and adult green turtles throughout the Wider Caribbean region (Bjorndal, 1995). (NMFS, NOAA 1998, p. 46694)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

Species	Habitat	Rationale	Source
<u>Sculpin, grotto</u> (<u>Cottus sp.</u>)	Grotto sculpin occupy cave streams, resurgences (also known as “spring branches”) (Vandike 1985, p. 10), springs, and surface streams (Adams 2012, pers. comm.; Adams et al. 2013, pp. 491–493; Burr et al. 2001, p. 284). They occupy pools and riffles with moderate flows and variable depths (4 to 33 centimeters (cm) (1.6 to 13 in)) (Burr et al. 2001, p. 284). Although grotto sculpin have been documented to occur over a variety of substrates (for example, silt, gravel, cobble, rock rubble, and bedrock), the presence of cobble or pebble is necessary for spawning (Burr et al. 2001, p. 284; Adams et al. unpub. data; Adams et al. 2013, pp. 491–492) (US FWS 2013, p. 58928).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat (58938) http://www.gpo.gov/fdsys/pkg/FR-2013-09-25/pdf/2013-23182.pdf
<u>Sea turtle, hawksbill</u> (<u>Eretmochelys imbricata</u>)	The hawksbill turtle occurs in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Coral reefs, like those found in the waters surrounding Mona and Monito Islands, are widely recognized as the primary foraging habitat of juvenile, subadult, and adult hawksbill turtles. This habitat association is directly related to the species’ highly specific	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

Species	Habitat	Rationale	Source
	diet of sponges (Meylan, 1988). Hawksbills depend on coral reefs for food and shelter; therefore, the condition of reefs directly affects the hawksbill's well-being. (NMFS, NOAA 1998, p. 46695)		
<u>Sea turtle, Kemp's ridley (Lepidochelys kempii)</u>	This life history pattern is characterized by three basic ecosystem zones: (1) Terrestrial zone (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) Neritic zone - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2011, p. I-8)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2011. Bi-national recovery plan for the kemp's ridley sea turtle. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

Species	Habitat	Rationale	Source
<u>Sea turtle, leatherback (Dermochelys coriacea)</u>	Leatherbacks are able to take advantage of a wide variety of marine ecosystems (reviewed by Saba 2013; see NOAA large marine ecosystem website: http://www.lme.noaa.gov/). Within these ecosystems, various oceanic features such as water temperature, downwelling, Ekman upwelling, sea surface height, chlorophyll-a concentration, and mesoscale eddies affect the presence of leatherbacks (Bailey et al. 2013; Benson et al. 2011). The physical characteristics observed within these marine ecosystems also affect the distribution and abundance of leatherback prey (reviewed by Saba 2013). (NMFS, NOAA 2013, p. 20-22).	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2013. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/090116.pdf
<u>Sea turtle, loggerhead Northwest Atlantic DPS (Caretta caretta)</u>	The three basic ecosystems in which loggerheads live are the: 1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur. 2. Neritic zone - the nearshore marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters. The neritic zone generally includes the	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2009. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

Species	Habitat	Rationale	Source
	<p>continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the neritic zone conventionally extends to areas where water depths are less than 200 meters.</p> <p>3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2009, p. I-20)</p>		
<u>Shiner, Arkansas River (Notropis girardi)</u>	<p>Wilde et al. (2000) found no obvious selection for or avoidance of any particular habitat type (i.e., main channel, side channel, backwaters, and pools) by Arkansas River shiner. Arkansas River shiners did tend to select side channels and backwaters slightly more than expected based on the availability of these habitats (Wilde et al. 2000). Likewise, they appeared to make no obvious selection for, or avoidance of, any particular substrate type. Substrates (i.e., the river bed) in the Canadian River in New Mexico and Texas were predominantly sand, however, the Arkansas River shiner was observed to occur over silt slightly more than expected based on the availability of this substrate (Wilde et al.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>US FWS. 2005. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/recovery_plan/950830.pdf</p>

Species	Habitat	Rationale	Source
	2000) ; preferred habitat for the Arkansas River shiner is the mainstem of larger plains rivers... historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin (Gilbert 1980). Adults are uncommon in quiet pools or backwaters lacking streamflow, and almost never occurred in habitats having deep water and bottoms of mud or stone (Cross 1967) (US FWS 2005).		
<u>Shiner, blue</u> <u>(Cyprinella</u> <u>caerulea)</u>	The blue shiner primarily occupies second to fourth order, moderate gradient streams within the Ridge and Valley and Piedmont physiographic provinces of Alabama, Georgia, and Tennessee (Smith-Vaniz 1968, Ramsey 1976, Krotzer 1984, Ramsey and Pierson 1986, Pierson and Krotzer 1987, Mayden 1989, Pierson et al. 1989, Boschung 1992, Etnier and Starnes 1993, Dobson 1994). Most watersheds where it is found are predominately forested, and agriculture and urban development are minimal. For example in Alabama, land cover in the Choccolocco watershed is 66 percent forest, 20 percent pasture, and 13 percent agriculture...It prefers a	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950830.pdf

Species	Habitat	Rationale	Source
	sand or sand and gravel substrate sometimes with cobble, low to moderate velocity current, and a depth of about 0.15 to 1 meters (0.5 to 3 feet) (Gilbert et al. 1979; Krotzer 1984, Pierson and Krotzer 1987, Dobson 1994) (US FWS 1995, p. 3-4)		
<u>Shiner, Topeka</u> (<u>Notropis topeka</u> (=tristis))	Topeka shiners are typically found in small, low order, prairie streams with good water quality, relatively cool temperatures, and low fish diversity. Although Topeka shiners can tolerate a range of water temperatures, cooler, spring-maintained systems are considered optimal. These streams generally maintain perennial flow but may become intermittent during summer or periods of drought, as long as there are refuge areas in headwaters springs or main channels of larger streams that do not provide adequate year-round habitat. While headwaters, oxbows and side channels provide the typical habitat, mainstem streams provide for dispersal as well as for	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/five_year_review/doc2585.pdf

Species	Habitat	Rationale	Source
	<p>drought refuge. The shiner is very often associated with groundwater discharges. Substrates are typically clean gravel, cobble, or sand, but may include bedrock and clay hardpan covered by a thin layer of silt, or coarse sand overlain by silt and detritus. Spawning is often over native sunfish nests (US FWS, 2004, pp, 44743-4).</p>		
<p><u>Snail, Iowa Pleistocene (Discus macclintocki)</u></p>	<p>The Iowa Pleistocene snail only occurs on high quality algific (cold producing) talus slopes with temperatures ranging from 35-45 degrees Fahrenheit. Air flows through fractured bedrock, over frozen groundwater, and out-vents on steep slopes to create a cold microclimate. These are talus covered slopes with thin soil that makes them extremely fragile and sensitive to disturbance, and irreplaceable. This habitat is known only to occur in the "driftless area" that overlaps where the states of Illinois, Iowa, Minnesota, and Wisconsin come together (US FWS, 2009, p. 11). All known areas are north-facing slopes, and the</p>	<p>The proposed dicamba DGA uses are not expected to overlap with algific talus slopes.</p>	<p>USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840322.pdf</p> <p>USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc2585.pdf</p>

Species	Habitat	Rationale	Source
	ground temperature seldom exceeds 50 degrees Fahrenheit even in the hottest summers (US FWS, 1984, p. 5).		
<u>Snail, painted snake coiled forest (Anguispira picta)</u>	This species is limited to Buck Creek Cove. It is found only in limestone outcrops in parts of the cove with good cover. The slopes of the cove are very steep with crock outcrops and sheer cliffs at intervals along both sides of the creek (US FWS, 1982).	The proposed dicamba DGA uses are not expected to overlap with creeks or stone outcrops along creeks.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060206.pdf
<u>Snake, copperbelly water (Nerodia erythrogaster neglecta)</u>	Copperbellies are generally affiliated with wetlands and prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (Cephalanthus occidentalis), emergent wetlands, or the margins of palustrine open water wetlands. Buttonbrush swamps are used as basking areas. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Uplands are also important. (US FWS, 2008, p. 17-18). Critical Habitat has not been designated for the snake because of concerns related to illegal collection (US FWS, 2008, p. 20).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2008. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/081223.pdf

Species	Habitat	Rationale	Source
<u>Spectaclecase (mussel)</u> <u>(Cumberlandia monodonta)</u>	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
<u>Spider. spruce-fir moss</u> <u>(Microhexura montivaga)</u>	Typical habitat appears to be associated with moist, well-drained moss mats growing on rocks and boulders in well-shaded situations in mature high-elevation conifer forests dominated by Fraser fir, <i>Abies fraseri</i> , often with scattered red spruce, <i>Picea rubens</i> . (US FWS 1998, p. iii)	The proposed dicamba DGA uses are not expected to overlap with high-elevation conifer forests.	US FWS, 1998, Recovery Plan. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
<u>Squirrel, Carolina northern flying</u> <u>(Glaucomys sabrinus coloratus)</u>	Species composition of the occupied forest may vary in different locations, some combination of hardwoods and conifers (particularly spruce and fir) appears essential to support these animals...Food sources for the Carolina northern flying squirrel include fungi, lichens, staminate cones, insects, and other animal matter (US FWS 1990, p. 6-7)	The proposed dicamba DGA uses are not expected to overlap with hardwood and conifer forests.	USFWS. 1990. Recovery Plan for Appalachian Northern Flying Squirrels. United States Fish and Wildlife Service.

Species	Habitat	Rationale	Source
<u>Stirrupshell</u> (<u>Quadrula</u> <u>stapes</u>)	Habitat is the Tombigbee River, characterized by an increasing number of sand and gravel shoals and decreasing channel size in the upper portions (US FWS, 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Sturgeon, gulf</u> (<u>Acipenser</u> <u>oxyrinchus</u> <u>desotoi</u>)	The Gulf sturgeon is an Anadromous fish which migrates from salt water into large coastal rivers to spawn and spend the warm months. The majority of its life is spent in fresh water (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950922.pdf
<u>Sturgeon, pallid</u> (<u>Scaphirhynchus</u> <u>albus</u>)	Habitat is the bottom in swift waters of large, turbid, free-flowing rivers, often over sand substrates, but other substrates include at least gravel and rock. Sloughs, chutes, and side channels that transition from floodplain to the main channels are apparently important as spawning, nursery, and feeding areas. Within the subject states, this habitat occurs in the Mississippi and Missouri rivers (US FWS, 1993, pp 6-7). Within this habitat, they tend to select main channel habitats in the Mississippi River, and main channel habitats with islands or sand bars in the upper Missouri River (US FWS, 2007. p. 8). They do not typically occur in impounded areas due	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Pallid%20Sturgeon%20Recovery%20Plan%20First%20Revision%20signed%20version%20012914_3.pdf USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1059.pdf

Species	Habitat	Rationale	Source
	to lower flows and other hydrologic factors, nor where channel stabilization has reduced channel meandering and access to floodplain areas (US FWS, 2007, p. 38).		
<u>Tern, least interior pop. (Sterna antillarum)</u>	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting occurs along river banks (US FWS, 1990, p. 20).	The proposed dicamba DGA uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf

Species	Habitat	Rationale	Source
<u>Tiger beetle, Salt Creek (Cicindela nevadica lincolniana)</u>	Very specific habitat requirements and occurs in saline wetlands—on exposed saline mud flats or along mud banks of streams and seeps that contain salt deposits and are sparsely vegetated (Carter 1989; Spomer and Higley 1993; LaGrange 1997; Spomer et al. 2004a). Larvae have been found only on moist salt flats and salt-encrusted banks of Little Salt Creek in northern Lancaster County (Spomer et al. 2004a) and saline wetlands associated with Rock Creek in the southern margin of Saunders County. Salt Creek tiger beetles require open, barren salt flat areas (US FWS 2009, p. 2).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	US FWS, 2009, Recovery Outline for the Salt Creek tiger beetle (2)
<u>Turtle, ringed map (Graptemys oculifera)</u>	Rivers and adjacent white sand beaches with basking sites (brush, logs debris) (USACE)	The proposed dicamba DGA uses are not expected to overlap with rivers or beaches.	USACE. Ringed Map Turtle Species Profile. US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory.
<u>Turtle, yellow-blotched map (Graptemys flavimaculata)</u>	Rivers and large creeks, prefers moderate currents, abundant basking sites, and sandbars (US FWS 1993, p. 2)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies and their associated beaches.	USFWS. 1993. Recovery Plan for the Yellow-blotched Map Turtle. United States Fish and Wildlife Service
<u>Vireo, black-capped (Vireo atricapilla)</u>	This species is an insect-eating, migratory songbird. They arrive in Texas from mid-March to mid-April, while those in Oklahoma arrive approximately 10 days later. Breeding	The proposed dicamba DGA uses are not expected to overlap with shrublands associated with rocky gullies, edges of ravines, or eroded slopes.	USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1073.pdf USFWS. 1991. Recovery Plan.

Species	Habitat	Rationale	Source
	<p>habitat is quite variable across its range, but is generally shrublands with a distinctive patchy structure. The shrub vegetation is mostly deciduous and generally extends from the ground to about six feet above ground and covers about 30 to 60% of the total area. Open grassland separates the clumps of shrubs. (US FWS 2007, p. 7)</p> <p>From Oklahoma through most of Texas, this type of vegetational configuration occurs most frequently on rocky substrates with shallow soils, in rocky gullies, on edges of ravines, and on eroded slopes. (US FWS 1991, p. 20)</p>		http://ecos.fws.gov/docs/recovery_plan/910930h.pdf
Kirtland's Warbler (Setophaga kirtlandii)	<p>Kirtland's warblers generally occupy jack pine stands that are 5-23 years old and at least 30 acres in size. Stands with less than 20% canopy over are rarely used for nesting. Occupied stands usually occur on dry, excessively drained and nutrient poor glacial outwash sands. They are structurally homogenous with trees ranging from 1.7-5.0 m in height (US FWS, 2012, p. 24). Species is migratory and mobile species and breeding areas are found in Wisconsin.</p>	<p>The proposed dicamba DGA salt uses are not expected to overlap with jack pine stands.</p>	<p>USFWS. 2012. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4045.pdf</p>

Species	Habitat	Rationale	Source
<u>Wartyback,</u> <u>white</u> <u>(pearlymussel)</u> <u>(Plethobasus</u> <u>cicatricosus)</u>	The white wartyback has undergone a substantial range reduction and is considered to be possibly extinct. It was historically distributed in the Wabash, Ohio, Kanawha, Cumberland, Holston, and Tennessee Rivers of the Ohio, Cumberland, and Tennessee River systems; however, no live specimens have been recovered from these drainages since the early 1900s). The white wartyback may still exist in a short reach of the Tennessee River below Pickwick Dam. No living populations have been found in numerous surveys conducted in the Tennessee River since the 1960s; however, fresh dead specimens were collected in 1979 and 1982 below Pickwick Dam near Savannah, Tennessee. If this species still exists, the viability of remaining populations is extremely threatened. The white wartyback is a riffle species that is typically found in large rivers in gravel substrates.	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	USFWS, 1984, Recovery Plan White Warty-backed Pearlymussel http://ecos.fws.gov/docs/recovery_plan/060313h.pdf http://ecos.fws.gov/docs/life_histories/F00M.html
<u>Whale, finback</u> <u>(Balaenoptera</u> <u>physalus)</u>	Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm

Species	Habitat	Rationale	Source
	less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally.		
<u>Whale, humpback (Megaptera novaeangliae)</u>	<p>During migration, humpbacks stay near the surface of the ocean.</p> <p>While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.</p> <p>Humpback feeding grounds are in cold, productive coastal waters.</p>	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm
<u>Woodpecker, red-cockaded Entire (Picoides borealis)</u>	<p>Habitat: Forest, Savannah (open pine woodlands and savannahs with large old pines) (US FWS 2003, p. x)</p> <p>Habitat size (home range): 116 – 357 acres (US FWS 2003, p. 49)</p>	Proposed dicamba DGA uses are not expected to overlap with forest or savannah.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf
Plants			
<u>Aster, decurrent false (Boltonia decurrens)</u>	The natural habitat of the aster was the shores of lakes and the banks of streams including the Illinois River. It appears to require abundant light. It presently grows in such	The proposed dicamba DGA uses are not expected to overlap with the shores of lakes/streams or other floodplain habitats where the aster may occur.	<p>USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900928c.pdf</p> <p>USFWS. 2012. 5-Year-Review.</p>

Species	Habitat	Rationale	Source
	habitats but is more common in disturbed lowland areas where it appears to be dependent on human activity for survival (US FWS, 1990, p. 3). It occupies unimpounded floodplain habitats along the Illinois River system; the plant relies on periodic flood pulses to maintain populations and suitable habitat (US FWS, 2012, p. 7).		http://ecos.fws.gov/docs/five_year_review/doc4044.pdf
<u>Aster, Ruth's golden</u> (<u>Pityopsis ruthii</u>)	This species grows only in the cracks or crevices found in phyllite or graywacke boulders along the banks of or within the Ocoee and Hiwassee Rivers (US FWS, 1992).	The proposed dicamba DGA uses are not expected to overlap with rivers.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920611.pdf
<u>Avens, spreading</u> (<u>Geum radiatum</u>)	This species grows in full sun on the shallow acidic soils of high-elevation cliffs, rocky outcrops, steep slopes, and on gravelly talus (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with high-elevation cliffs, rocky outcrops, steep slopes or gravelly talus.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930428.pdf
<u>bladderpod, Missouri</u> (<u>Physaria filiformis</u>)	This species grows in shallow soils on limestone glades and outcrops in pastures and rarely in rocky open woods. Grows in shallowest soils with other annuals where bare soil occurs and few perennials are present. Burlington limestone of Mississippian age (US FWS, 1998).	The proposed dicamba DGA uses are not expected to overlap with pasture outcrops and rocky open wooded areas.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/880407.pdf
<u>Bluet, Roan Mountain</u> (<u>Hedyotis purpurea</u> var. <u>montana</u>)	This species grows in shallow soils and crevices of cliffs and outcrops and on thin rocky soils of grassy balds (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with cliffs and outcrops.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960513.pdf

Species	Habitat	Rationale	Source
<u>Bush-clover, prairie</u> (<u>Lespedeza leptostachya</u>)	The prairie bush clover occurs on both undisturbed and disturbed sites over sandy, loam, or gravelly soils included at the thin margins near rock outcrops. Sites may have been previously mowed, burned or grazed (US FWS, 1988, p. 7-8).	The proposed dicamba DGA uses are not expected to overlap with prairies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/881006.pdf
<u>Butterfly plant, Colorado</u> (<u>Gaura neomexicana</u> var. <u>coloradensis</u>)	This species requires early- to mid-succession riparian habitat. It commonly occurs in habitat types that are usually intermediate in moisture between wet, streamside communities dominated by sedges, rushes, and cattails, and dry, upland short-grass prairie. Typically, Colorado butterfly plant habitat is open, without dense or overgrown vegetation (US FWS, 2010).	The proposed dicamba DGA uses are not expected to overlap with riparian habitat or upland prairies.	USFWS. 2010. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Colorado%20Butterfly%20Plant%20Recovery%20Outline_Final_May%202010.pdf
<u>Chaffseed, American</u> (<u>Schwalbea americana</u>)	Habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with pine flatwoods, fire-maintained savannas, wetland or sedge dominated systems.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950929c.pdf
<u>Clover, running buffalo</u> (<u>Trifolium stoloniferum</u>)	Running buffalo clover occurs in mesic habitats of partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions	The proposed dicamba DGA uses are not expected to overlap with mesic habitats where the clover is expected to be found.	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

Species	Habitat	Rationale	Source
	underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).		
<u>Daisy, Lakeside (Hymenoxys herbacea)</u>	Although historical habitats include outcrops of dolomite or limestone bedrock, dry, gravelly prairies on terraces or hills associated with major river systems, rocky shores, sandy fields and alvars, the Lakeside daisy in the U. S. is now restricted to dry, thin-soiled, degraded prairies in which limestone or dolomite bedrock is at or near the surface. Habitats are alkaline, seasonally wet in spring and fall, and are moderately to extremely droughty in summer. Typically, habitats have little topographic relief, are relatively open at the	The proposed dicamba DGA uses are not expected to overlap with quarries and dry prairies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf

Species	Habitat	Rationale	Source
	ground surface, and vegetation density and diversity are relatively low. Within these habitats, lakeside daisy occurs in open patches of ground, occupies the dry to mesic portions of the soil moisture continuum and has a highly aggregated distribution. This species is either absent or infrequently found in shaded or densely vegetated areas (US FWS, 1990, pp. 20-21).		
<u>Fern, American hart's-tongue (Asplenium scolopendrium var. americanum)</u>	Early successional habitats Northern populations occur in forests of secondary growth where canopy openings are abundant. New York populations occur in conifer forests. Bryophyte beds are an important substrate.	The proposed dicamba DGA uses are not expected to overlap early successional forests, conifer forests or bryophyte beds where the species is found.	http://ecos.fws.gov/docs/recovery_plan/930915.pdf
<u>Geocarpon minimum (No common name)</u>	This species grows on sandstone glades and outcrops as well as bare, sparsely vegetated areas where the soil contains relatively large amounts of magnesium and sodium salts (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with the sandstone glades and outcrops where this species is expected to be found.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930726.pdf
<u>Goldenrod, Blue Ridge (Solidago spithamea)</u>	This species grows on rock outcrops and vertical to near vertical cliffs in southern Appalachians of western North Carolina and extreme eastern TN. Rocky summits and cliffs usually appear as smaller-scale patchy habitats embedded in larger forest consisting of	The proposed dicamba DGA uses are not expected to overlap with rock outcrops and vertical cliffs.	USFWS. 1987. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/blueridge%20goldenrod%20rp.pdf

Species	Habitat	Rationale	Source
	spruce-fir or northern hardwoods or occasionally high elevation red oak forest (US FWS, 1987).		
Goldenrod, Short's (Solidago shortii)	The habitat of Short's goldenrod is open areas in full sun or partial shade. Known occurrences are in limestone cedar glades, open eroded areas, edges, of open oak-hickory woods, cedar thickets, pastures, old fields, power line rights-of-way and rock ledges along rights-of-way. Cedar glades and woodland edges appear to be the natural habitat. Short's goldenrod was known historically and currently only from Kentucky when the Recovery Plan was written in 1988 (US FWS, pp. 3-4). An Indiana occurrence was located in 2001 along the Blue River in riparian habitat (US FWS, 2007, p. 6).	The proposed dicamba DGA salt uses are not expected to overlap with glades, woodland edges, pastures, or other habitat favorable for goldenrod growth.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/shortsgrodRP.pdf USFWS. 2007. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc1609.pdf
<u>Grass, Tennessee yellow-eyed (Xyris tennesseensis)</u>	Xyris tennesseensis is a rare perennial monocot that is an obligate wetland plant that prefers relatively high pH seeps and streambanks. An Obligate wetland plant that is restricted to calcareous seeps, fens, and spring runs (US FWS, 2014).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2014. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4360.pdf
<u>Ground-plum, Guthrie's (=Pyne's)</u>	This species is endemic to cedar glades (US FWS, 2011).	The proposed dicamba DGA uses are not expected to overlap with cedar glades.	USFWS. 2011. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/20110722b_Pynes

Species	Habitat	Rationale	Source
<u>(Astragalus bibullatus)</u>			%20ground%20plum_RP_final_1.pdf
<u>Harperella (Ptilimnium nodosum)</u>	Harperella is known from only two locations in North Carolina. One population occurs in the Tar River in Granville County. Another population was reintroduced to the Deep River recently after the original population known from that area disappeared. This population occurs in Chatham County, but the river serves as the divide between Chatham and Lee counties (US FWS, 1991).	The proposed dicamba DGA uses are not expected to overlap with river habitats.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910305b.pdf
<u>Iris, dwarf lake (Iris lacustris)</u>	The dwarf lake iris grows along the northern shorelines of lakes Michigan and Huron in Wisconsin, Michigan and Ontario, Canada. It typically occurs in shallow soil over moist calcareous sands, gravel and beach rubble. Sunlight is one of the most critical factors to the growth and reproduction of the species and partly shaded or sheltered forest edges are optimal for sexual reproduction. Some form of disturbance is also required to maintain the forest openings that provide these partial shade conditions. The species is most often associated with shoreline coniferous forests dominated by	The proposed dicamba DGA uses are not expected to overlap with shoreline coniferous forests.	USFWS. 2013. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/DLI%20RP%20FINAL%20AUG2013_1.pdf

Species	Habitat	Rationale	Source
	northern white cedar and balsam fir. The principal limiting factor for dwarf lake iris is the availability of this suitable shoreline habitat (US FWS, 2013, pp. 6-7).		
<u>Ladies'-tresses, Ute (Spiranthes diluvialis)</u>	<p>Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to mois soils in mesic or wet meadows near springs, lakes, or perrenial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations are found in riparian woodlands. Observed to be shade-intolerant (US FWS, 1995).</p> <p>Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations als found in</p>	The proposed dicamba DGA uses are not expected to overlap with riverine, spring, or lakeside wet meadows.	<p>USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950921.pdf</p> <p>USFWS. Species Profile Page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2WA</p>

Species	Habitat	Rationale	Source
	riparian woodlands. Observed to be shade-intolerant (US FWS, Species Profile Page).		
<u>Lichen, rock gnome (Gymnoderma lineare)</u>	<p>Rock gnome lichen is primarily limited to vertical rock faces where seepage water from forest soils above flows during (and only during) very wet times. It appears the species needs a moderate amount of light, but that it cannot tolerate high-intensity solar radiation. It does well on moist, generally open, sites, with northern exposures, but needs at least partial canopy coverage where the aspect is southern or western</p> <p>Rock gnome lichen is known from the Southern Appalachian Mountains of North Carolina and South Carolina, Tennessee, and Georgia, in areas of high humidity, either at high elevations, where it is frequently bathed in fog, or in deep gorges at lower elevations.</p>	The proposed dicamba DGA uses are not expected to overlap with high elevation vertical rock faces where the species occurs.	http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html
<u>Lily, Minnesota dwarf trout (Erythronium propullans)</u>	The Minnesota dwarf trout lily is most commonly found in the lower parts of wooded north-facing slopes, and on adjacent floodplains. Sites are associated either with streams or abandoned stream channels, dominated by deciduous trees. It may	The proposed dicamba DGA uses are not expected to overlap with woodlands or floodplains.	USFWS. 1987. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060309c.pdf

Species	Habitat	Rationale	Source
	be intolerant of shade (US FWS, 1987).		
<u>Locoweed,</u> <u>Fassett's</u> <u>(Oxytropis</u> <u>campestris var.</u> <u>chartacea)</u>	<p>Fassett's locoweed grows along the shorelines of small, landlocked, hardwater lakes where the bedrock is overlain by sandy glacial drift. Nearly all lakes with historical populations of the species are less than 15 ha in size and occur at approximately 350 m elevation. Dependent upon groundwater seepage for their water supply, most are shallow (maximum depth of a few meters) and subject to frequent, large fluctuations in water level.</p> <p>Fassett's locoweed is found along the lakes on open shoreline and, to a lesser extent, on higher ground under the partial shade of adjacent vegetation. It grows on gentle, sandgravel slopes and is absent from flat, low, mucky shorelines dominated by cattails and bulrushes. Because of periodic fluctuations in lake levels, the amount of exposed, open shoreline varies, from being virtually nonexistent during times of high water, to about 30 m wide when the water level is low. In all cases, Fassett's locoweed occurs in areas which are</p>	The proposed dicamba DGA uses are not expected to overlap with the shorelines of lakes.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910329.pdf

Species	Habitat	Rationale	Source
	completely exposed to sunlight or receive only partial shade from other species. (US FWS, 1991, pp.4-5).		
<u>Milkweed,</u> <u>Mead's</u> <u>(Asclepias</u> <u>meadii)</u>	Mead's milkweed occurs primarily in tallgrass prairie with a late successional bunch-grass structure, but also occurs in hay meadows and in thin soil glades or barrens. This plant is essentially restricted to sites that have never been plowed and only lightly grazed, and hay meadows that are cropped annually for hay (US FWS, 2003, p. 9).	The proposed dicamba DGA uses are not expected to overlap with tallgrass prairies, hay meadows, or thin soil glades or barrens.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030922b.pdf
<u>Monkshood,</u> <u>northern wild</u> <u>(Aconitum</u> <u>noveboracense)</u>	Typical habitat is shaded to partially shaded cliffs and talus slopes or in New York, also occurs in semi-shaded seepage springs at high elevation headwaters. Various bedrock types from sandstones to dolomite and others act as substrates. All habitats have a cold soil environment associated with active and continuous cold air drainage or cold ground water flowage out of the nearby bedrock. Typically cliff and talus slope populations are associated with openings or caves, often ice-filled, through which the cold air emanates (US FWS, 1983, p. 18-20).	The proposed dicamba DGA uses are not expected to overlap with cliffsides, rockfalls at cliff bases or springs associated with cold air or water.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/830923.pdf

Species	Habitat	Rationale	Source
<u>Orchid, eastern prairie fringed</u> (<u>Platanthera leucophaea</u>)	The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	The proposed dicamba DGA uses are not expected to overlap with grass or sedge-dominated plant communities.	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf
<u>Orchid, western prairie fringed</u> (<u>Platanthera praeclara</u>)	The western prairie-fringed orchid occurs primarily in tall grass prairies dominated by bluestem grass and in sedge meadows that are seasonally wet (US FWS, 1996, p. 6). They also may occur in successional communities such as borrow pits, old fields, and roadside ditches (US FWS, 1996, p. 4).	The proposed dicamba DGA uses are not expected to overlap with prairie, meadow areas, roadside ditches, borrow pits or abandoned fields.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930a.pdf
<u>Penstemon, blowout</u> (<u>Penstemon haydenii</u>)	This species grows in depressions in the topography caused by wind erosion. Vegetation associated with blowouts is distinctly different than	The proposed dicamba DGA uses are not expected to overlap with sandy slough slopes or dunes.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920717.pdf

Species	Habitat	Rationale	Source
	<p>vegetation associated with adjacent, non-eroding areas.</p> <p>In Wyoming, blowout penstemon is found primarily on the rim and lee slopes of blowouts, or the rim and steep faces of sandy slough slopes. These deposits are found at the base of mountains or ridges, which represent topographic barriers. Shifting sand dunes are prevented from becoming fully stabilized and overgrown because of wind and gravity. The dunes may be 60 to 120 feet high (US FWS, 1992).</p>		
<u>Pitcher-plant, green (Sarracenia oreophila)</u>	<p>Habitats for this species can be generally grouped into two types: stream banks (considered ephemeral) and upland bogs. Upland bogs, fire dependent, range from open to forested, underlain by semi-impervious clay layers (US FWS, 1994).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with stream banks or upland bogs.</p>	<p>USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/941212.pdf</p>
<u>Pogonia, small whorled (Isotria medeoloides)</u>	<p>The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most</p>	<p>The proposed dicamba DGA uses are not expected to overlap with mixed deciduous/coniferous forests.</p>	<p>USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf</p>

Species	Habitat	Rationale	Source
	occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).		
<u>Pondberry</u> (<u>Lindera</u> <u>melissifolia</u>)	Associated with seasonally flooded wetlands. Found on wet edges of sandy sinks, ponds, and swampy depressions. Shade tolerant (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930923a.pdf
<u>Potato-bean</u> , <u>Price's (Apios</u> <u>priceana)</u>	Found in open forests along the edges of forests, creeks, and rivers (US FWS, 1993, p. executive summary).	The proposed dicamba DGA uses are not expected to overlap with forests, or water bodies.	USFWS. 1993. Recovery Plan http://ecos.fws.gov/docs/recovery_plan/930210.pdf
<u>Prairie-clover</u> , <u>leafy (Dalea</u> <u>foliosa)</u>	Leafy prairie-clover is found only in open limestone cedar glades, limestone barrens, and dolomite prairies which have shallow, silt to silty clay loam soils	The proposed dicamba DGA uses are not expected to overlap with prairies or areas with visible bedrock.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf

Species	Habitat	Rationale	Source
	over flat and often highly fractured, horizontally bedded limestone or dolomite with frequent expanses of exposed bedrock at surface. Elevations are typically between 550 and 700 feet. These habitats experience high surface and soil temperatures, generally have low soil moisture but are wet in the spring and fall and become droughty in summer. The distribution of glade, barren, and dry to wet dolomite prairie at any particular site varies and leads to a mosaic of soils and their associated plant communities (USFWS, 1996, p.13).		
<u>Quillwort, Louisiana (Isoetes louisianensis)</u>	This species grows in sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland. bayhead forests of fine flatwoods and upland longleaf pine (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with streams, overflow channels, or riparian woodlands.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930b.pdf
<u>Rock-cress, Braun's (Arabis perstellata)</u>	Braun's rockcress occurs on the slopes of calcareous mesophytic and sub-xeric forest types. The occurrence of this species does not appear to be limited to a particular slope aspect, elevation, or moisture regime within the slope forests. It is, however, sun intolerant and always occurs in at least partial shade. The	The proposed dicamba DGA uses are not expected to overlap with calcareous mesophytic and sub-xeric forested systems.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970722.pdf

Species	Habitat	Rationale	Source
	largest and most vigorous populations occur on moist mid- to upper slope sites. Plants are often found around rock outcrops, protected sites on the downslope side of tree bases, and sites of natural disturbance, such as talus slopes and animal trails. It is rarely found growing among the Leaf litter and herbaceous cover of the forest floor (US FWS, 1997).		
<u>Rosemary, Cumberland (Conradina verticillata)</u>	This species is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (pg. 8) (US FWS, 2011).	The proposed dicamba DGA uses are not expected to overlap with rivers.	USFWS. 2011. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3629.pdf
<u>Roseroot, Leedy's (Rhodiola)</u>	New York populations occur on cliffs along the western shore of Seneca lake. In Minnesota,	The proposed dicamba DGA uses are not expected to overlap with cliffs.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980925.pdf

Species	Habitat	Rationale	Source
<u>integrifolia ssp. leedyi</u>	populations occur on moderate cliffs, which are cooled by air exiting underground passages in the karst topography (US FWS, 1998).		
<u>Sandwort, Cumberland (Arenaria cumberlandensis)</u>	This species is restricted to sandstone rock houses, ledges, and solution pockets on sandstone rock faces; The species is found on the sandy floors of rock houses, in solution pockets on the face of sandstone cliffs, and on ledges beneath overhanging sandstone (pg. 4) (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with sandstone rock houses, ledges, or rock faces.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960620.pdf
<u>Skullcap, large-flowered (Scutellaria montana)</u>	This species occurs in slope, ravine, and stream-bottom forests in northwestern Georgia and adjacent southeastern Tennessee. Habitat loss and lack of information on appropriate management are the factors limiting the number of viable populations (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with ravine and stream-bottom forests.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960515.pdf
<u>Sneezeweed, Virginia (Helenium virginicum)</u>	Seasonal wetlands, sink hole ponds varying from forest settings to farm pond margins.	The proposed dicamba DGA uses are not expected to overlap sink hole ponds and seasonal wetlands.	http://ecos.fws.gov/docs/recovery_plan/001002.pdf

Species	Habitat	Rationale	Source
<u>Spiraea</u> , <u>Virginia</u> (<u>Spiraea</u> <u>virginiana</u>)	<i>Spiraea virginiana</i> is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-18.).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf
<u>Thistle</u> , <u>Pitcher's</u> (<u>Cirsium</u> <u>pitcheri</u>)	It occurs on non-forested sand dunes of several types (grassland dunes, simple linear beach foredunes, continuous and discontinuous dune complexes), sand beaches, and sandy blowouts, primarily occurring around the Great Lakes (US FWS, 2002, p. 23-27).	The proposed dicamba DGA uses are not expected to overlap with sand dunes, sand beaches, or sandy blowouts.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920b.pdf

Appendix 3. Designated Critical Habitat Modification Determinations

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis consistent with the Overview Document (USEPA, 2004) as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species. The Agency will conclude 'modification' of designated critical habitat if the range of designated critical habitat co-occurs with the states subject to the Federal action and one or more of the following conditions exist:

1. The available Services' information indicates that cotton or soybean fields are habitat for the species and there is a "may affect" determination for the species associated with exposure to Dicamba DGA salt or its degradate DCSA, as labeled.
2. The available Services' information indicates that the species uses cotton or soybean fields and one or more effects on taxonomic groups predicted for dicamba DGA salt or its degradate DCSA, on cotton or soybean fields would modify one or more of the designated PCEs.

If the above conditions are not met, EPA concludes 'no modification.'

Results of Analysis

Of the 183 listed species within the 16 states there are 173 species identified in the effects determinations as not using cotton or soybean fields and 10 species using these fields. Critical habitats have been designated for 59 of the 183 species. Fifty-three species with critical habitat were judged to not use cotton or soybean fields and so the critical habitat determination for these was no modification. The remaining 6 species with critical habitat designations were assumed to use cotton or soybean fields and so the previous listed species effects determinations were consulted to ascertain if any were determined to be at risk for direct adverse effects. None of the species were determined to be at risk for direct adverse effects, so the PCE's listed in the Services' critical habitat designations were consulted to determine if, in light of the screening assessment risk findings, they would be impacted by on-field exposure to dicamba DGA salt. For all but one of these species, the PCE's are not relatable to agricultural fields and so a determination of no modification has been made for these 5 species.

The only species using cotton or soybean fields and with critical habitat PCE's relatable to agricultural fields was the whooping crane, for which agricultural fields were discussed as providing waste grain as a potential food source for migratory cranes. The potential pathway for applications of dicamba DGA salt to affect this PCE is by making grain potentially toxic to the birds. Because there is unlikely to be any edible waste grain remaining following cotton harvesting, it is unlikely that the proposed dicamba DGA salt use on cotton could affect this PCE. However, the proposed use on soybean could affect this PCE by making waste soybean grain potentially toxic.

The Health Effect Division summarized available soybean grain residues of dicamba in the Human Health Risk Assessment for the Registration Eligibility Decision for Dicamba and Associated Salts (DP317703). Based on the soybean trials results, maximum residues of dicamba were 0.04 ppm in hay, 0.097 ppm in forage, and 8.13 ppm in seed 6-8 days post treatment (MRIDs 43814101 and 44089307). These measured values were used to set the tolerance value of 10 ppm for soybean seeds. The measured residues are not

reasonably expected to be at a level raising a concern for direct effects to the whooping crane because the direct effects assessment for this species (presented on pages 9-10 of this assessment) did not establish a concern for residues in other dietary items at much **higher** (~ 1 order of magnitude) concentrations than would occur at the maximum measured residues in seed or if residues were present even at the tolerance level of 10.0 ppm. Because this analysis shows no direct effects of dicamba at levels that would be expected in the fields as waste grain, an indirect effect, there is no modification of critical habitat. Similarly, measured DCSA residues in waste soybean grain (0.44 ppm) would be well below the estimated DCSA concentrations in arthropods (42.5 ppm) used in the direct effects assessment for this species (pp 9-10). Therefore, whooping crane critical habitat within the 16 states would not be modified.

Summary of Determinations for Critical Habitat

The Agency has determined that the proposed labeled use of dicamba DGA salt on cotton and soybeans will not modify designated critical habitat for the 59 species for which such habitats have been designated in AR, IL, IN, IA, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI.

Summary of listed species identified as not being on agricultural fields with and without critical habitat designations for the first 16 states assessed for dicamba DGA salt

Critical Habitat Designation	Species Name
<i>Species with Critical Habitat Designations (53 Species)²</i>	Bean, Purple (<i>Villosa perpurpurea</i>)
	Butterfly Plant, Colorado (<i>Gaura neomexicana</i> var. <i>coloradensis</i>)
	Butterfly, Karner Blue (<i>Lycaeides melissa samuelis</i>)
	Cavesnail, Tumbling Creek (<i>Antrobia culveri</i>)
	Chub, Slender (<i>Erimystax cahni</i>)
	Chub, Spotfin (<i>Erimonax monachus</i>)
	Clubshell, Ovate (<i>Pleurobema perovatum</i>)
	Clubshell, Southern (<i>Pleurobema decisum</i>)
	Combshell, Cumberlandian (<i>Epioblasma brevidens</i>)
	Combshell, Upland (<i>Epioblasma metastriata</i>)
	Dace, Laurel (<i>Chrosomus saylori</i>)
	Darter, Amber (<i>Percina antesella</i>)
	Darter, Cumberland (<i>Etheostoma susanae</i>)
	Darter, Leopard (<i>Percina pantherina</i>)
	Darter, Niangua (<i>Etheostoma nianguae</i>)
	Darter, Slackwater (<i>Etheostoma boschungii</i>)
	Darter, Snail (<i>Percina tanasi</i>)
	Darter, Yellowcheek (<i>Etheostoma moorei</i>)
	Dragonfly, Hine's Emerald (<i>Somatochlora hineana</i>)
	Elktoe, Appalachian (<i>Alasmidonta raveneliana</i>)
	Elktoe, Cumberland (<i>Alasmidonta atropurpurea</i>)
	Frog, Dusky Gopher (<i>Rana sevosa</i>)
	Kidneyshell, Fluted (<i>Ptychobranhus subtentum</i>)
	Kidneyshell, Triangular (<i>Ptychobranhus greenii</i>)
	Logperch, Conasauga (<i>Percina jenkinsi</i>)
	Lynx, Canada (<i>Lynx canadensis</i>)

² Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Critical Habitat Designation	Species Name
	Madtom, Chucky (<i>Noturus crypticus</i>)
	Madtom, Smoky (<i>Noturus baileyi</i>)
	Madtom, Yellowfin (<i>Noturus flavipinnis</i>)
	Manatee, West Indian (<i>Trichechus manatus</i>)
	Moccasinshell, Alabama (<i>Medionidus acutissimus</i>)
	Moccasinshell, Coosa (<i>Medionidus parvulus</i>)
	Mucket, Neosho (<i>Lampsilis rafinesqueana</i>)
	Mucket, Orangenacre (<i>Lampsilis perovalis</i>)
	Mussel, Oyster (<i>Epioblasma capsaeformis</i>)
	Pearlymussel, Slabside (<i>Pleuonaia dolabelloides</i>)
	Pigtoe, Georgia (<i>Pleurobema hanleyianum</i>)
	Pigtoe, Southern (<i>Pleurobema georgianum</i>)
	Plover, Piping (Great Lakes DPS, Northern Great Plains DPS) (<i>Charadrius melodus</i>)
	Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)
	Rabbitsfoot, Rough (<i>Quadrula cylindrica strigillata</i>)
	Rock-Cress, Braun's (<i>Arabis perstellata</i>)
	Sculpin, Grotto (<i>Cottus sp.</i>)
	Sea Turtle, Green (<i>Chelonia mydas</i>)
	Sea Turtle, Hawksbill (<i>Eretmochelys imbricata</i>)
	Sea Turtle, Kemp's Ridley (<i>Lepidochelys kempii</i>)
	Sea Turtle, Leatherback (<i>Dermochelys coriacea</i>)
	Sea Turtle, Loggerhead Northwest Atlantic DPS (<i>Caretta caretta</i>)
	Shiner, Arkansas River (<i>Notropis girardi</i>)
	Shiner, Topeka (<i>Notropis topeka</i> (=tristis))
	Spruce-Fir Moss Spider (<i>Microhexura montivaga</i>)
	Sturgeon, Gulf (<i>Acipenser oxyrinchus desotoi</i>)
	Tiger Beetle, Salt Creek (<i>Cicindela nevadica lincolniana</i>)
Species without Critical Habitat Designations (123 species)	Acornshell, Southern (<i>Epioblasma othcaloogensis</i>)
	Amphipod, Illinois Cave (<i>Gammarus acherondytes</i>)
	Aster, Decurrent False (<i>Boltonia decurrens</i>)
	Aster, Ruth's Golden (<i>Pityopsis ruthii</i>)
	Avens, Spreading (<i>Geum radiatum</i>)
	Bat, Gray (<i>Myotis grisescens</i>)
	Bean, Cumberland (pearlymussel) (<i>Villosa trabalis</i>)
	Bladderpod, Missouri (<i>Physaria filiformis</i>)
	Blossom, Green (pearlymussel) (<i>Epioblasma torulosa gubernaculum</i>)
	Blossom, Tubercled (pearlymussel) (<i>Epioblasma torulosa torulosa</i>)
	Blossom, Turgid (pearlymussel) (<i>Epioblasma turgidula</i>)
	Blossom, Yellow (pearlymussel) (<i>Epioblasma florentina florentina</i>)
	Bluet, Roan Mountain (<i>Hedyotis purpurea</i> var. <i>montana</i>)
	Bush-Clover, Prairie (<i>Lespedeza leptostachya</i>)
	Butterfly, Mitchell's Satyr (<i>Neonympha mitchellii mitchellii</i>)
	Catspaw, White (<i>Epioblasma obliquata perobliqua</i>)

Critical Habitat Designation	Species Name
	Cavefish, Ozark (<i>Amblyopsis rosae</i>)
	Chaffseed, American (<i>Schwalbea americana</i>)
	Clover, Running Buffalo (<i>Trifolium stoloniferum</i>)
	Clubshell (<i>Pleurobema clava</i>)
	Clubshell, Black (<i>Pleurobema curtum</i>)
	Combshell, Southern (<i>Epioblasma penita</i>)
	Crayfish, Cave (<i>Cambarus aculabrum</i>)
	Crayfish, Cave (<i>Cambarus zophonastes</i>)
	Crayfish, Nashville (<i>Orconectes shoupi</i>)
	Dace, Blackside (<i>Phoxinus cumberlandensis</i>)
	Daisy, Lakeside (<i>Hymenoxys acaulis</i> var. <i>glabra</i> (herbacea))
	Darter, Bayou (<i>Etheostoma rubrum</i>)
	Darter, Bluemask (=jewel) (<i>Etheostoma</i> sp.)
	Darter, Boulder (<i>Etheostoma wapiti</i>)
	Darter, Duskytail (<i>Etheostoma percnurum</i>)
	Disc, Iowa Pleistocene (<i>Discus macclintocki</i>)
	Fanshell (<i>Cyprogenia stegaria</i>)
	Fatmucket, Arkansas (<i>Lampsilis powellii</i>)
	Fern, American Hart's-Tongue (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)
	Ferret, Black-Footed (<i>Mustela nigripes</i>)
	<i>Geocarpon minimum</i> (No common name)
	Goldenrod, Blue Ridge (<i>Solidago spithamea</i>)
	Goldenrod, Short's (<i>Solidago shortii</i>)
	Grass, Tennessee Yellow-Eyed (<i>Xyris tennesseensis</i>)
	Ground-Plum, Guthrie's (=Pyne's) (<i>Astragalus bibullatus</i>)
	Harperella (<i>Ptilimnium nodosum</i>)
	Heelsplitter, Alabama (=inflated) (<i>Potamilus inflatus</i>)
	Hellbender, Ozark (<i>Cryptobranchus alleganiensis bishopi</i>)
	Higgins Eye Pearlymussel (<i>Lampsilis higginsii</i>)
	Iris, Dwarf Lake (<i>Iris lacustris</i>)
	Lampmussel, Alabama (<i>Lampsilis virescens</i>)
	Lichen, Rock Gnome (<i>Gymnoderma lineare</i>)
	Lilliput, Pale (pearlymussel) (<i>Toxolasma cylindrellus</i>)
	Lily, Minnesota Dwarf Trout (<i>Erythronium propullans</i>)
	Locoweed, Fassett's (<i>Oxytropis campestris</i> var. <i>chartacea</i>)
	Madtom, Neosho (<i>Noturus placidus</i>)
	Madtom, Pygmy (<i>Noturus stanauli</i>)
	Madtom, Scioto (<i>Noturus trautmani</i>)
	Marstonia, Royal (snail) (<i>Pyrgulopsis ogmorhapse</i>)
	Milkweed, Mead's (<i>Asclepias meadii</i>)
	Monkeyface, Appalachian (pearlymussel) (<i>Quadrula sparsa</i>)
	Monkeyface, Cumberland (pearlymussel) (<i>Quadrula intermedia</i>)
	Monkshood, Northern Wild (<i>Aconitum novoboarense</i>)
	Mucket, Pink (pearlymussel) (<i>Lampsilis abrupta</i>)
	Mussel, Mapleleaf Winged (<i>Quadrula fragosa</i>)
	Mussel, Scaleshell (<i>Leptodea leptodon</i>)

Critical Habitat Designation	Species Name
	Mussel, Sheepnose (<i>Plethobasus cyphus</i>)
	Mussel, Snuffbox (<i>Epioblasma triquetra</i>)
	Orchid, Western Prairie White-fringed (<i>Platanthera praeclara</i>)
	Orchid, Eastern Prairie White-fringed (<i>Platanthera leucophaea</i>)
	Pearlshell, Louisiana (<i>Margaritifera hembeli</i>)
	Pearlymussel, Birdwing (<i>Lemiox rimosus</i>)
	Pearlymussel, Cracking (<i>Hemistena lata</i>)
	Pearlymussel, Curtis (<i>Epioblasma florentina curtisii</i>)
	Pearlymussel, Dromedary (<i>Dromus dromas</i>)
	Pearlymussel, Fat Pocketbook (<i>Potamilus capax</i>)
	Pearlymussel, Littlewing (<i>Pegias fabula</i>)
	Penstemon, Blowout (<i>Penstemon haydenii</i>)
	Pigtoe, Cumberland (<i>Pleurobema gibberum</i>)
	Pigtoe, Finerayed (<i>Fusconaia cuneolus</i>)
	Pigtoe, Flat (<i>Pleurobema marshalli</i>)
	Pigtoe, Rough (<i>Pleurobema plenum</i>)
	Pigtoe, Shiny (<i>Fusconaia cor</i>)
	Pimpleback, Orangefoot (<i>Plethobasus cooperianus</i>)
	Pitcher-Plant, Green (<i>Sarracenia oreophila</i>)
	Pocketbook, Ouachita Rock (<i>Arkansia wheeleri</i>)
	Pocketbook, Speckled (<i>Lampsilis streckeri</i>)
	Pogonia, Small Whorled (<i>Isotria medeoloides</i>)
	Pondberry (<i>Lindera melissifolia</i>)
	Potato-Bean, Price's (<i>Apios priceana</i>)
	Prairie-Clover, Leafy (<i>Dalea foliosa</i>)
	Purple Cat's Paw (<i>Epioblasma obliquata obliquata</i>)
	Quillwort, Louisiana (<i>Isoetes louisianensis</i>)
	Rayed Bean (<i>Vilosa fabalis</i>)
	Riffleshell, Northern (<i>Epioblasma torulosa rangiana</i>)
	Riffleshell, Tan (<i>Epioblasma florentina walkeri</i> (= <i>E. walkeri</i>))
	Ring Pink (mussel) (<i>Obovaria retusa</i>)
	Riversnail, Anthony's (<i>Athearnia anthonyi</i>)
	Rosemary, Cumberland (<i>Conradina verticillata</i>)
	Roseroot, Leedy's (<i>Rhodiola integrifolia</i> ssp. <i>leedyi</i>)
	Sandwort, Cumberland (<i>Arenaria cumberlandensis</i>)
	Sawfish, Smalltooth (<i>Pristis pectinata</i>)
	Shiner, Blue (<i>Cyprinella caerulea</i>)
	Skullcap, Large-Flowered (<i>Scutellaria montana</i>)
	Snail, Painted Snake Coiled Forest (<i>Anguispira picta</i>)
	Sneezeweed, Virginia (<i>Helenium virginicum</i>)
	Spectaclecase Mussel (<i>Cumberlandia monodonta</i>)
	Spiraea, Virginia (<i>Spiraea virginiana</i>)
	Squirrel, Carolina Northern Flying (<i>Glaucomys sabrinus coloratus</i>)
	Stirrupshell (<i>Quadrula stapes</i>)
	Sturgeon, Pallid (<i>Scaphirhynchus albus</i>)

Critical Habitat Designation	Species Name
	Tern, Least (<i>Sterna antillarum</i>)
	Thistle, Pitcher's (<i>Cirsium pitcheri</i>)
	Turtle, Ringed Map (<i>Graptemys oculifera</i>)
	Turtle, Yellow-Blotched Map (<i>Graptemys flavimaculata</i>)
	Ute, Ladies'-Tresses, (<i>Spiranthes diluvialis</i>)
	Vireo, Black-Capped (<i>Vireo atricapilla</i>)
	Warbler, Kirtland's (<i>Dendroica kirtlandii</i>)
	Wartyback, White (pearlymussel) (<i>Plethobasus cicatricosus</i>)
	Watersnake, Northern Copperbelly (<i>Nerodia erythrogaster neglecta</i>)
	Whale, Finback (<i>Balaenoptera physalus</i>)
	Whale, Humpback (<i>Megaptera novaeangliae</i>)
	Woodpecker, Red-Cockaded (<i>Picoides borealis</i>)

Summary of listed species identified as being on agricultural fields with and without critical habitat designations for the first 16 states assessed for dicamba DGA salt:

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species with Critical Habitat Designations (6 Species)</i>³		
Bat, Indiana (<i>Myotis sodalis</i>)	PCE: Shelter during winter hibernation. Critical habitat designations are either mines or caves.	http://ecos.fws.gov/docs/federal_register/fr161.pdf http://ecos.fws.gov/docs/federal_register/fr83.pdf
Bat, Ozark (<i>Corynorhinus townsendii ingens</i>)	PCE: Not specified. Critical habitat designations are caves.	http://ecos.fws.gov/docs/federal_register/fr171.pdf
Bear, Louisiana Black (<i>Ursus americanus luteolus</i>)	PCE: Habitat components that provide: (i) Breeding habitat (i.e., within or contiguous to the home range of females in a core breeding population) consisting of hardwood forest areas having a diversity of age class and species and containing sources of hard mast (acorns and nuts) produced by such species as mature oaks, hickories, and pecan, and that may include one or more of the following: (A) Areas containing soft mast provided by a diversity of plant species, including, but not limited to, blackberry, grape, mulberry, sassafras, paw paw, etc., occurring primarily in forest openings, on spoil banks, and in areas adjacent to forested habitat. (B) Areas within forested habitat providing protein sources consisting of beetles and other colonial insects found in rotting and decaying wood found on the forest floor.	http://www.gpo.gov/fdsys/pkg/FR-2009-03-10/pdf/E9-4536.pdf#page=1

³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Species Name	Primary Constituent Elements (PCE)	Source
	<p>(C) Grasses and sedges found in forest openings, on spoil banks with open canopies, and in vegetated areas adjacent to forested habitats.</p> <p>(D) Secure areas for reproduction, winter dormancy, day bedding, and escape. These include areas with den trees (e.g., bald cypress, overcup oak, American sycamore, etc.); areas with a thick understory, shrub-scrub habitat, openings along spoil banks, vegetated areas adjacent to forests, or any vegetation that provides cover, limits visibility, slows foot travel, or creates noise when traversed; early successional forests (0 to 12 years) with an open canopy and dense understory of shrubs, vines, and saplings; or areas with vegetation such as palmetto, greenbriars, blackberry, dewberry, and downed trees.</p> <p>(ii) Corridors consisting of:</p> <p>(A) Habitat patches 12 acres (5 hectares) or greater in size; or</p> <p>(B) Forested areas greater than 150 feet (46 meters) wide along waterways and sloughs and having a diversity of plant species and age-classes of sufficient area, quality, and configuration, as described in paragraph (2)(i) of this entry, to provide dispersal habitat between breeding populations to maintain genetic variability and promote stable or increasing populations, and to provide habitat supporting safe movement, foraging, and denning.</p>	
Crane, Mississippi Sandhill (<i>Grus canadensis pulla</i>)	PCE: Not specified.	http://ecos.fws.gov/docs/federal_register/fr150.pdf
Crane, Whooping (<i>Grus Americana</i>)	<p>PCE: All areas proposed in this rule would provide food, water, and other nutritional or physiological needs of the whooping crane during spring or fall migration. (1) Insects, crayfish, frogs, small fish, and other small animals as well as some aquatic vegetation and some cereal crops in adjacent croplands appear to be major items taken during the migration period. Consumption of some cereal crops in adjacent croplands during migration period. (2) Require an open expanse for nightly rooting, especially sand and gravel bars or very shallow water in rivers and lakes. (3) Whooping cranes are territorial and require several acres of undisturbed wetlands. (4) Potential nesting habitat.</p>	<p>http://ecos.fws.gov/docs/federal_register/fr237.pdf</p> <p>http://ecos.fws.gov/docs/federal_register/fr214.pdf</p>
Wolf, Gray (<i>Canis lupis</i>)	PCE: Not specified.	http://ecos.fws.gov/docs/federal_register/fr186.pdf

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species without critical habitat designations (4 species)</i>		
Beetle, American burying (<i>Nicrophorus americanus</i>)	No critical habitat rules have been published.	n/a
Bladderpod, Spring Creek (<i>Lesquerella perforata</i>) ⁴	No critical habitat rules have been published.	n/a
Prairie-chicken, Lesser (<i>Tympanuchus pallidicinctus</i>)	No critical habitat rules have been published.	n/a
Tortoise, Gopher (<i>Gopherus polyphemus</i>)	No critical habitat rules have been published.	n/a

⁴ Bold text indicates assessed species with “may effect, likely to adversely affect” determination.

Appendix 4. Foliar Half-Life Calculations

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
0.5 lb/A application					
DMA+ Salt	FL	0	71	SFO	8.98
	FL	7	35		
	FL	14	26		
	FL	28	11		
	FL	56	0.53		
	GA	0	78	TR IORE	2.89
	GA	7	10		
	GA	14	7.1		
	GA	28	1.5		
	GA	56	0.3		
	IN	0	69	TR IORE	8.46
	IN	7	15		
	IN	14	16		
	IN	28	4.6		
	IN	56	3		
	KS	0	81	TR IORE	6.16
	KS	7	25		
	KS	14	11		
	KS	28	6.5		
	KS	56	2.5		
	MI	0	27	TR IORE	4.69
	MI	7	6.9		
	MI	14	3		
	MI	28	1		
	MI	56	0.8		
	MO	0	20	SFO	7.03
	MO	7	10		
	MO	14	4.2		
	MO	28	2.6		
	MO	56	1.8		
	NE	0	28	SFO	5.13
	NE	7	12		
	NE	14	2.7		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	NE	28	1.3	SFO	2.98
	NE	56	0.64		
	OK 1	0	41		
	OK 1	7	8		
	OK 1	14	1.7		
	OK 1	28	0.79		
	OK 1	56	0.75		
	OK 2	0	61	TR IORE	5.58
	OK 2	7	15		
	OK 2	14	11		
	OK 2	28	1.8		
	OK 2	56	1.2		
	OR	0	31	TR IORE	1.14
	OR	7	2		
	OR	14	3.6		
	OR	28	3.7		
	OR	56	1.3		
	TN	0	20	TR IORE	3.18
	TN	7	2.2		
	TN	14	2.5		
	TN	28	0.71		
	TN	56	0.74		
	TX	0	35	SFO	4.42
	TX	7	11		
	TX	14	4.5		
	TX	28	1.9		
	TX	56	3.2		
	WI	0	39	TR IORE	4.3
	WI	7	9		
	WI	14	4.3		
	WI	28	1		
	WI	56	0.74		
DGA+ Salt	GA	0	55	TR IORE	3.18
	GA	7	6.3		
	GA	14	7.7		
	GA	28	1.1		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	GA	56	0.21		
	MO	0	22		
	MO	7	10		
	MO	14	5.8		
	MO	28	5.9		
	MO	56	1.4		
	OK 1	0	32	TR IORE	1.84
	OK 1	7	2.6		
	OK 1	14	2.8		
	OK 1	28	1.3		
	OK 1	56	0.34		
	OR	0	20	SFO	3.77
	OR	7	1.6		
	OR	14	8		
	OR	28	2.2		
	OR	56	0.59		
	WI	0	45	TR IORE	2.53
	WI	7	5.5		
	WI	14	2.4		
	WI	28	1.2		
	WI	56	0.45		
Na+ Salt	GA	0	57	SFO	6.9
	GA	7	41		
	GA	14	4.3		
	GA	28	1.4		
	GA	56	1		
	MO	0	25	TR IORE	11
	MO	7	9.3		
	MO	14	6.6		
	MO	28	3.4		
	MO	56	0.92		
	OK 1	0	23	TR IORE	7.23
	OK 1	7	9.2		
	OK 1	14	4.1		
	OK 1	28	2.4		
	OK 1	56	0.33		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OR	0	29	TR IORE	2.84
	OR	7	3.5		
	OR	14	5.5		
	OR	28	2.8		
	OR	56	3.3		
	WI	0	42	TR IORE	2.67
	WI	7	5.2		
	WI	14	3.1		
	WI	28	0.68		
	WI	56	0.38		
DMA+ Salt	FL	0	76	SFO	12.3
	FL	7	36		
	FL	14	38		
	FL	28	19		
	FL	56	1.6		
	GA	0	87	TR IORE	4.08
	GA	7	18		
	GA	14	8.1		
	GA	28	4.3		
	GA	56	0.4		
	IN	0	102		
	IN	7	306		
	IN	14	48		
	IN	28	16		
	IN	56	2.6		
	KS	0	49	TR IORE	12.1
	KS	7	28		
	KS	14	18		
	KS	28	8.6		
	KS	56	2.4		
	MI	0	44	TR IORE	4.75
	MI	7	11		
	MI	14	3.7		
	MI	28	3.1		
	MI	56	1.2		
	MO	0	42	TR IORE	6.93

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).

Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	MO	7	5.7		
	MO	14	5.8		
	MO	28	4.5		
	MO	56	2.2		
	NE	0	54	TR IORE	3.84
	NE	7	12		
	NE	14	4.5		
	NE	28	1.4		
	NE	56	0.74		
	OK 1	0	47	SFO	5.02
	OK 1	7	20		
	OK 1	14	4		
	OK 1	28	1.7		
	OK 1	56	0.36		
	OK 2	0	101	TR IORE	5.77
	OK 2	7	30		
	OK 2	14	15		
	OK 2	28	6.8		
	OK 2	56	0.88		
	OR	0	11	SFO	35.2
	OR	7	5.6		
	OR	14	3.2		
	OR	28	7.7		
	OR	56	2.9		
	TN	0	5		
	TN	7	5.9		
	TN	14	3.5		
	TN	28	3.2		
	TN	56	0.96		
	TX	0	77	TR IORE	6.67
	TX	7	21		
	TX	14	11		
	TX	28	6.9		
	TX	56	2.9		
	WI	0	571	TR IORE	1.11
	WI	7	21		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
DGA+ Salt	WI	14	4.2		
	WI	28	4.1		
	WI	56	0.82		
	FL	0	65	TR IORE	4.38
	FL	7	14		
	FL	14	8.5		
	FL	28	1.8		
	FL	56	0.069		
	MI	0	29	TR IORE	17.3
	MI	7	9.7		
	MI	14	9.8		
	MI	28	3.3		
	MI	56	2.7		
	NE	0	36	TR IORE	5.92
	NE	7	14		
	NE	14	6		
	NE	28	2.1		
	NE	56	0.078		
	OK 2	0	9.1	SFO	28.9
	OK 2	7	5.3		
	OK 2	14	4.1		
	OK 2	28	5.3		
	OK 2	56	2.2		
	TX	0	99	SFO	2.83
	TX	7	18		
	TX	14	2.5		
	TX	28	4.6		
	TX	56	0.81		
Na+ Salt	FL	0	60	TR IORE	4.81
	FL	7	18		
	FL	14	7.1		
	FL	28	2.5		
	FL	56	0.26		
	MO	0	51	TR IORE	8.43
	MO	7	7.1		
	MO	14	8.9		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	MO	28	4.3	SFO	7
	MO	56	3.4		
	OK 1	0	62		
	OK 1	7	29		
	OK 1	14	7.8		
	OK 1	28	21		
	OK 1	56	0.93		
	OR	0	14	SFO	14.9
	OR	7	7.2		
	OR	14	4.1		
	OR	28	6		
	OR	56	2.3		
	WI	0	110	SFO	2.89
	WI	7	21		
	WI	14	1.2		
	WI	28	1.4		
	WI	56	0.4		
1.0 lb/A application					
Dicamba acid	FL	0	120	TR IORE	10.3
	FL	7	33		
	FL	14	26		
	FL	28	19		
	FL	56	0.72		
	GA	0	88	TR IORE	4.18
	GA	7	21		
	GA	14	8.6		
	GA	28	3		
	GA	56	0.46		
	IN	0	116	TR IORE	9.81
	IN	7	41		
	IN	14	27		
	IN	28	17		
	IN	56	1.4		
	KS	0	116	TR IORE	9.37
	KS	7	30		
	KS	14	24		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	KS	28	14		
	KS	56	3.4		
	MI	0	75	SFO	4.74
	MI	7	29		
	MI	14	6.5		
	MI	28	3.3		
	MI	56	1.6		
	MO	0	53	TR IORE	14.8
	MO	7	25		
	MO	14	14		
	MO	28	11		
	MO	56	3.6		
	NE	0	34	SFO	5.36
	NE	7	15		
	NE	14	3.9		
	NE	28	1.6		
	NE	56	0.8		
	OK 1	0	81	TR IORE	2.74
	OK 1	7	10		
	OK 1	14	6.8		
	OK 1	28	1.2		
	OK 1	56	0.88		
	OK 2	0	119	TR IORE	5.25
	OK 2	7	30		
	OK 2	14	17		
	OK 2	28	6.3		
	OK 2	56	1.1		
	OR	0	43	SFO	3.37
	OR	7	5.1		
	OR	14	12		
	OR	28	7.4		
	OR	56	3		
	TN	0	78	TR IORE	1.87
	TN	7	7.4		
	TN	14	2.4		
	TN	28	2.5		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	TN	56	1.6	SFO	4.06
	TX	0	84		
	TX	7	25		
	TX	14	8		
	TX	28	2.6		
	TX	56	3.1		
	WI	0	64	TR IORE	5.15
	WI	7	16		
	WI	14	9.5		
	WI	28	2.5		
	WI	56	0.9		
2.0 lb/A application					
DMA+ Salt	FL	0	206	SFO	11.5
	FL	7	163		
	FL	14	81		
	FL	28	35		
	FL	56	1.6		
	FL	0	487	TR IORE	9.75
	FL	7	155		
	FL	14	138		
	FL	28	53		
	FL	56	4.6		
	GA	0	251	TR IORE	4.49
	GA	7	52		
	GA	14	36		
	GA	28	6.6		
	GA	56	0.51		
	GA	0	310	TR IORE	4.28
	GA	7	63		
	GA	14	39		
	GA	28	10		
	GA	56	0.58		
	IN	0	240	SFO	10.2
	IN	7	131		
	IN	14	83		
	IN	28	57		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	IN	56	5		
	IN	0	477	SFO	7.17
	IN	7	67		
	IN	14	220		
	IN	28	110		
	IN	56	6.1		
	KS	0	273	TR IORE	4.82
	KS	7	50		
	KS	14	35		
	KS	28	18		
	KS	56	4.6		
	KS	0	245	TR IORE	8.84
	KS	7	72		
	KS	14	49		
	KS	28	28		
	KS	56	8.1		
	MI	0	96	SFO	8.56
	MI	7	85		
	MI	14	15		
	MI	28	3.8		
	MI	56	1.8		
	MI	0	202	SFO	3.53
	MI	7	54		
	MI	14	6.3		
	MI	28	8.2		
	MI	56	2.1		
	MO	0	82	SFO	16.4
	MO	7	57		
	MO	14	34		
	MO	28	33		
	MO	56	8		
	MO	0	136	SFO	9.85
	MO	7	63		
	MO	14	47		
	MO	28	33		
	MO	56	14		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	NE	0	115	SFO	3.91
	NE	7	35		
	NE	14	6.4		
	NE	28	2.8		
	NE	56	2.1		
	NE	0	227	TR IORE	2.49
	NE	7	26		
	NE	14	15		
	NE	28	6.5		
	NE	56	2.2		
	OK 1	0	131	TR IORE	3.64
	OK 1	7	18		
	OK 1	14	18		
	OK 1	28	2.5		
	OK 1	56	2.3		
	OK 1	0	174	TR IORE	5.75
	OK 1	7	64		
	OK 1	14	28		
	OK 1	28	7		
	OK 1	56	5.5		
	OK 2	0	138	SFO	8.69
	OK 2	7	53		
	OK 2	14	64		
	OK 2	28	12		
	OK 2	56	2.6		
	OK 2	0	412	TR IORE	4.98
	OK 2	7	77		
	OK 2	14	57		
	OK 2	28	26		
	OK 2	56	6.3		
	OR	0	71	SFO	5.52
	OR	7	16		
	OR	14	23		
	OR	28	12		
	OR	56	4.9		
	OR	0	33		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OR	7	28		
	OR	14	32		
	OR	28	44		
	OR	56	19		
	TN	0	99	TR IORE	1.22
	TN	7	7.9		
	TN	14	4.1		
	TN	28	5.5		
	TN	56	2		
	TN	0	82	TR IORE	4.09
	TN	7	12		
	TN	14	8.8		
	TN	28	5.5		
	TN	56	2.4		
	TX	0	64	SFO	12.3
	TX	7	78		
	TX	14	19		
	TX	28	6.3		
	TX	56	9		
	TX	0	346	SFO	4.64
	TX	7	120		
	TX	14	39		
	TX	28	28		
	TX	56	5.5		
	WI	0	98	SFO	4.59
	WI	7	35		
	WI	14	10		
	WI	28	3.8		
	WI	56	2.6		
	WI	0	116	SFO	10.5
	WI	7	138		
	WI	14	14		
	WI	28	16		
	WI	56	4		
DGA+ Salt	GA	0	244	TR IORE	3.55
	GA	7	45		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	GA	14	22		
	GA	28	5.2		
	GA	56	0.42		
	GA	0	509	TR IORE	2.64
	GA	7	61		
	GA	14	39		
	GA	28	12		
	GA	56	1		
	MO	0	75	SFO	19.3
	MO	7	79		
	MO	14	52		
	MO	28	23		
	MO	56	10		
	MO	0	132	TR IORE	23.3
	MO	7	38		
	MO	14	48		
	MO	28	23		
	MO	56	6.8		
	OK 1	0	123	SFO	3.03
	OK 1	7	24		
	OK 1	14	6.2		
	OK 1	28	8.6		
	OK 1	56	2.4		
	OK 1	0	231	SFO	6.19
	OK 1	7	126		
	OK 1	14	30		
	OK 1	28	7.5		
	OK 1	56	0.92		
	OR	0	69	SFO	4.23
	OR	7	8		
	OR	14	24		
	OR	28	18		
	OR	56	2.6		
	OR	0	49		
	OR	7	29		
	OR	14	27		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OR	28	37	TR IORE	5.24
	OR	56	12		
	WI	0	98		
	WI	7	27		
	WI	14	13		
	WI	28	5.1		
	WI	56	1.6		
	WI	0	287	SFO	3.17
	WI	7	64		
	WI	14	8		
	WI	28	15		
	WI	56	2.7		
Na+ Salt	GA	0	358		
	GA	7	8.2		
	GA	14	47		
	GA	28	6.4		
	GA	56	0.17		
	GA	0	559	TR IORE	2.39
	GA	7	62		
	GA	14	36		
	GA	28	9.3		
	GA	56	0.1		
	MO	0	92	SFO	11.2
	MO	7	54		
	MO	14	28		
	MO	28	28		
	MO	56	7.3		
	MO	0	134	SFO	7.61
	MO	7	39		
	MO	14	56		
	MO	28	17		
	MO	56	15		
	OK 1	0	131	TR IORE	9.49
	OK 1	7	28		
	OK 1	14	28		
	OK 1	28	14		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).

Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OK 1	56	4.7	SFO	4.75
	OK 1	0	206		
	OK 1	7	71		
	OK 1	14	31		
	OK 1	28	3		
	OK 1	56	3.9		
	OR	0	94	TR IORE	8.24
	OR	7	9.4		
	OR	14	16		
	OR	28	15		
	OR	56	1		
	OR	0	44	SFO	43.7
	OR	7	38		
	OR	14	11		
	OR	28	50		
	OR	56	7.7		
	WI	0	99	TR IORE	4.41
	WI	7	19		
	WI	14	13		
	WI	28	3.9		
	WI	56	0.72		
	WI	0	342	TR IORE	2.83
	WI	7	45		
	WI	14	23		
	WI	28	14		
	WI	56	1.4		
				Mean	7.272828
				Standard Deviation	6.580145
				n	99
				Maximum	43.7
				Minimum	1.11
				Upper 90% CI on the mean	8.360618

¹ 2012 Memorandum from the Fate Tech Team: Release of NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media.

Appendix 5. Lesser Prairie-Chicken habitat characteristics identified by Jamison et al. (2002).

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
1	New Mexico	Cropland, idle, shinnery oak (<i>Quercus havardii</i>) pasture, shortgrass pasture, tame pasture	Hens with broods preferred shinnery oak pasture over cropland, fallow cropland, shortgrass, and tame pastures; broods used sites characterized by 25% canopy cover of vegetation, canopy height of about 30 cm, 24-39% basal composition of shrubs, 47-60% grasses, and 13-26% basal composition of forbs; adults used grain sorghum fields during autumn and winter
2	Kansas	Cropland, sand sagebrush (<i>Artemisia filifolia</i>) pasture	Nested in sand sagebrush pasture and foraged in cropland during winter
3	Oklahoma	Burned shinnery oak pasture, burned tame pasture, shinnery oak pasture	Continued to display at a lek in burned pasture; males relocated from an unburned lek to a historical site in a burned weeping lovegrass (<i>Eragrostis curvula</i>) pasture and initiated display at a new site in burned shinnery oak/bluestem (<i>Andropogon</i>) pasture
4	Oklahoma	Sand sagebrush pasture, shinnery oak pasture	Densities of birds in shinnery oak pasture were positively correlated with grass cover and grass frequency along transects, and with percent of grassland cover types identified from satellite imagery; in sand sagebrush pasture, numbers of birds were positively correlated with percent cover of shrubs and grass frequency along transects, but were not associated with percentages of cover types identified from satellite imagery
5	Oklahoma	Cropland, mixed-grass pasture, sand sagebrush pasture, shinnery oak pasture	Nested in residual grasses and shinnery oak; raised broods in shinnery oak thickets; foraged in cropland (food plots) during winter
6	Texas	Honey mesquite (<i>Prosopis glandulosa</i>)/shortgrass pasture, shinnery oak pasture	Preferred pastures dominated by shinnery oak and sand bluestem (<i>Andropogon hallii</i>); avoided honey mesquite/shortgrass areas; nested more successfully in residual sand bluestem than in other vegetation types; selected nest sites with north or northeast aspects, more litter and less bare ground than elsewhere in the habitat, and taller vegetation than the average vegetation height within 3 m; broods preferred shinnery oak/sand bluestem pasture and avoided mesquite/shortgrass habitat; broods foraged at sites with a minimum vegetation height of 24 cm and lower grass

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
			abundance and greater shrub abundance than generally was available
7	Oklahoma	Cropland, native pasture	Displayed on sparsely vegetated, flat-topped ridges overlooking expansive areas of native pasture and on slightly raised knolls that provided unobstructed views of broad valleys
8	Oklahoma	Sand sagebrush pasture, shinnery oak pasture	More individuals were encountered in phenoxy herbicide-treated shinnery oak and phenoxy herbicide-treated sand sagebrush pastures than in untreated habitats of the same types
9	Colorado	Sand sagebrush pasture	Nested among taller grasses (36 vs. 27 cm), forbs (21 vs. 16 cm), and shrubs (48 vs. 38 cm), and denser vegetation (32 vs. 20 cm) compared to areas within 5 m; nested mostly under sand sagebrush and yucca (<i>Yucca glauca</i>); at 29 nest sites, tallest vegetation averaged 51 cm, sand sagebrush plant density was 3471 plants/ha, sand sagebrush cover was 7.2%, grass cover was 29.4%, forb cover was 1.4%, and bare ground was 69.5%
10	Texas	Shinnery oak/sand sagebrush pasture	Selected untreated shinnery oak pastures for nesting over tebuthiuron-treated pastures of the same type; eight of 10 females that were captured in tebuthiuron-treated areas later nested in untreated shinnery oak; 13 nests were in residual grasses with 42% overhead cover, average plant height of 45 cm, and average visual obstruction of 61-80% in the first 33 cm above ground; vegetation was dominated by purple three-awn (<i>Aristida purpurea</i>) at nine nest sites, little bluestem (<i>Schizachyrium scoparium</i>) at three nests, and sand bluestem at one nest
11	Colorado	Cropland, mixed-grass pasture, sand sagebrush pasture	Males displayed at lek sites on slightly elevated terrain or on level flats; foraged in cropland during winter
12	Texas	Cropland, sand sagebrush pasture, shinnery oak pasture	Used pastures vegetated by sand sagebrush, chickasaw plum (<i>Prunus angustifolia</i>), fragrant sumac (<i>Rhus aromatica</i> var. <i>trilobata</i>), shinnery oak, sand bluestem, little bluestem, sand lovegrass (<i>Eragrostis trichodes</i>), sand dropseed (<i>Sporobolus cryptandrus</i>), thin paspalum (<i>Paspalum setaceum</i>), switchgrass (<i>Panicum virgatum</i>), Indiangrass (<i>Sorghastrum nutans</i>), and various forbs; foraged in cropland during winter

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
13	Kansas	Cropland, sand sagebrush pasture	Males preferred habitats vegetated by sand sagebrush, blue grama (<i>Bouteloua gracilis</i>), sideoats grama (<i>Bouteloua curtipendula</i>), paspalum (<i>Paspalum</i> sp.), bluestem, western ragweed (<i>Ambrosia psilostachya</i>), sunflowers (<i>Helianthus</i> spp.), Russian-thistle (<i>Salsola iberica</i>), prickly pear (<i>Opuntia</i> sp.), and yucca and used cultivated fields, tallgrass and CRP, and other grassland habitats less than expected; median sizes of areas used by males were 12-140 ha in April and May, 77-144 ha from June through September, and 229-409 ha in October and November
14	Oklahoma	Sand sagebrush/mixed-grass pasture	Displayed in areas dominated by buffalograss; raised broods in areas with 22.8% sand sagebrush and 15.7% western ragweed; foraged in mixed-grass, rested among shrubs, and nested in residual grasses; broods also used shrubs; on a year-round basis, foraged mostly in grass, especially mixed-grass 25-80 cm in height; tallgrass, shortgrass, and shrub vegetation were used equally; sixweeks fescue (<i>Festuca octoflora</i>) and fragrant sumac were important food items; during spring, used shrubs <80 cm tall; used grasses and forbs 25-80 cm in height during summer, and grasses 25-80 cm tall during autumn; in winter, used tallgrass (specific heights of tallgrass species were not given)
15	New Mexico	Cropland, shinnery oak/sand sagebrush pasture	Used pastures vegetated by shinnery oak, bluestem grasses, sand sagebrush, sunflower, honey mesquite, plum, yucca, dropseed, black grama (<i>Bouteloua eriopoda</i>), blue grama, and sideoats grama; foraged in grain sorghum and corn fields from fall through spring
16	New Mexico, Oklahoma, Texas	Cropland, shinnery oak pasture, shinnery oak/little bluestem pasture	Annual rates of habitat change were greater around leks with declining populations than at leks with stable populations (1.14% vs. 0.21% annually)
17	New Mexico	Shinnery oak pasture, shortgrass pasture	Displayed on oil pads and in native pasture
18	New Mexico	Cropland, oldfield, shinnery oak pasture, shortgrass pasture, tame pasture	Nested in shinnery oak habitats with little bluestem, sand bluestem, and purple three-awn; avoided weeping lovegrass, cultivated, oldfield, and shortgrass habitats

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
19	New Mexico, Texas	Shinnery oak/sand sagebrush pasture	Occurred in similar densities in tebuthiuron-treated and untreated shinnery oak pastures
20	New Mexico	Shinnery oak pasture, shortgrass pasture	Nested in shinnery oak habitats dominated by sand bluestem; vegetation was taller at 10 successful than 26 unsuccessful nests (67 vs. 35 cm); percent composition of shrubs was similar at successful and unsuccessful nests (basal composition 31-66%); 22 autumn foraging sites were 63% grasses and 37% shrubs, 50 winter sites were 59% grasses and 41% shrubs (forbs were rare); broods foraged in 25-cm tall shinnery oak and three-awn (<i>Aristida</i> sp.), bare ground at 12 sites averaged 63%, basal composition of vegetation was 43% grass, 42% shrubs, and 15% forbs; daily movements of 40 prenesting females were 390 m/day within 231-ha ranges; 12 nesting hens moved 250 m/day, and ranges averaged 92 ha; three hens with broods moved an average of 280 m/day within 119-ha ranges; movements of 19 females without broods was 220 m/day within 73-ha ranges
22	New Mexico	Shinnery oak/sand sagebrush pasture	Hens generally used habitats with large unstable sand dunes, abundant shinnery oak, low grass cover, and low structural density; nested in sand sagebrush, residual grasses, and shinnery oak; five of eight nests were under sand sagebrush, two nests were in purple three-awn, and one nest was in shinnery oak; visual obstruction and canopy cover of sand sagebrush were significantly higher at nest sites than in surrounding habitat (specific values for visual obstruction, canopy cover, and canopy height were not given)
23	Texas	Cropland, oldfield, shinnery oak pasture, shortgrass pasture, tame pasture	Prenesting and nesting hens preferred shinnery oak habitat characterized by rolling dunes and dominated primarily by shinnery oak, habitat dominated by little bluestem and sand bluestem, or habitat dominated by three-awn and shinnery oak; canopy coverage of grasses within 3 m of nest sites was 3.1-13.2%, shrub canopy was 21.4-28.3%, and canopy coverage of all vegetation was 31.4-38.4%; nests in grasses were more successful (4 of 5 successful) than those under shrubs (3 of 10 successful)
24	New Mexico	Cropland, oldfield, shinnery oak pasture, shortgrass pasture, tame pasture	Prenesting and nesting hens preferred shinnery oak habitat characterized by rolling dunes and dominated primarily by shinnery oak, habitat dominated by little bluestem and sand bluestem, or

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
			habitat dominated by three-awn and shinnery oak; canopy coverage of grasses within 3 m of nest sites was 3.1-13.2%, shrub canopy was 21.4-28.3%, and canopy coverage of all vegetation was 31.4-38.4%; nests in grasses were more successful (4 of 5 successful) than those under shrubs (3 of 10 successful)
25	New Mexico, Oklahoma, Texas	Cropland, shinnery oak pasture, shinnery oak/little bluestem pasture	Populations stabilized or increased in landscapes (7238-ha areas) in which low-density shrubland composed 79.% of the total area and declined in landscapes with 43.2% low-density shrubland; total shrubland composed 81.9% around leks that did not decline and 63.4% of the landscape around declining leks; declined in areas where landscapes were unstable (e.g., experienced frequent changes from one landcover to another); population trends were positively correlated with loss of total shrubland



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

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MEMORANDUM

Subject: Addendum to Dicamba Diglycolamine (DGA) Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States (Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas)

To: Grant Rowland, Risk Manager Reviewer
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Through: Mark Corbin, Branch Chief
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Prior to conducting this refined Endangered Species Assessment, the Environmental Fate and Effects Division (EFED) performed a screening level ecological risk assessment for a Federal

action involving proposed new uses of the diglycolamine salt of dicamba (dicamba DGA) on dicamba herbicide-tolerant soybean on March 8, 2011 (DP 378444); an amendment to the assessment was issued on May 20, 2014 (DP 404138, 404806, 405887, 410802, and 411382). Concurrent with this refined Endangered Species Assessment, a Section 3 New Use dicamba DGA salt on dicamba-tolerant cotton screening-level assessment (DP 404823) and a subsequent addendum (DP 426789) that addresses multiple issues (spray drift buffers, runoff, risk to terrestrial invertebrates and updated mammalian toxicological endpoints for parent dicamba and its degradate, DCSA) have been finalized. In the screening level risk assessment, potential direct risk concerns could not be excluded for:

- mammals (chronic, from the soybean use only, due to residues from dicamba's metabolite, DCSA, rather than from parent dicamba);
- birds (acute from parent dicamba for both soybean and cotton uses; chronic from DCSA residues only in soybean but not in cotton), considered surrogates for reptiles, and terrestrial-phase amphibians; and
- terrestrial plants (soybean and cotton uses)

In the screening level risk assessments, indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Additionally, the screening level assessments showed that direct risk concerns were unlikely (*i.e.* levels of concern were not exceeded) for:

- mammals (acute) and (chronic—for the cotton use only);
- birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton);
- terrestrial insects (acute and chronic);
- freshwater fish (acute and chronic);
- aquatic-phase amphibians (acute and chronic);
- estuarine/marine fish (acute and chronic);
- freshwater invertebrates (acute and chronic); estuarine/marine invertebrates (acute and chronic); and
- aquatic plants¹

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk

¹ The listed species LOC was exceeded for non-vascular aquatic plants, however there are no listed species of this taxa.

Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations. At each screening step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still exceeds the Agency’s levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. When a given taxonomic RQ exceeds either the acute or chronic LOC a concern for direct toxic effects is identified for that particular taxon. If RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

The purpose of this document is to explain the refined risk assessment conducted for Federally-listed threatened or endangered (listed) species that could potentially be impacted by this pesticide registration. The refined assessment was conducted based on the 2004 Overview document, as discussed above. The assessment of risks to listed species posed by the use of Dicamba DGA has been conducted in phases covering a specific set of states, assessing risk to all the listed species covered in those states. This assessment covers the endangered species analysis for 7 states: Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina and Texas. Based on EFED’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), 307 species in the 7 states proposed for registration were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant soybean and cotton uses. **Table 1** presents a summary of this assessment. Separate concurrent assessment phases cover the endangered species analysis for 16 states (D416416, 420160, 420159, 420352, 421434, 421723 covering AR, IL, IA, IN, KS, LA,

MN, MS, MO, NE, ND, OH, OK, SD, TN and WI) and 11 states (D425049 covering AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV).

EPA consulted U.S. Fish and Wildlife Service Recovery Plans to determine whether listed species in these states would be expected to occur in an action area encompassing the treated soybean and corn fields. The refined assessment was then conducted on those species that could not be excluded from the action area. EPA also consulted the recovery plans in the refined assessment for additional habitat information and incorporated species biological information regarding dietary items (used to model dicamba DGA residues in prey tissue) and body weight (used to determine food consumption rates and scale ecotoxicity data from the tested surrogate species, the bobwhite quail and rat, to the body weight of the listed species).

The Environmental Fate and Effects Division (EFED) has completed an endangered species risk assessment for Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas in support of registering dicamba diglycolamine (DGA) salt on herbicide-tolerant cotton and soybean in these states. **Table 1** presents a summary of the assessment.

Table 1. Summary of species effects determinations and critical habitat modification determinations for Federally threatened or endangered species in Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas for dicamba DGA use on genetically modified cotton and soybeans.

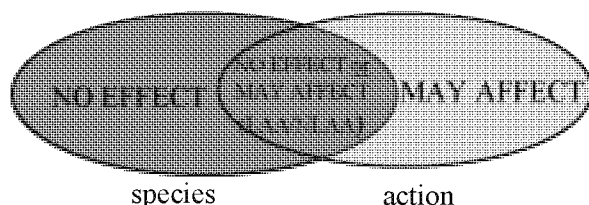
Species	Effects Determination	Comments
Eskimo Curlew	May Affect, Not Likely to Adversely Affect	Found in 24 counties (23 in Nebraska and 1 in Texas)
All other species (terrestrial and aquatic)	No effect	None
Critical Habitat	Modification Determination	Comments
All Critical Habitats (118 species)	No Modification	None

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have **NO EFFECT**.
- For listed individuals outside the action area, use of a pesticide would be determined to have **NO EFFECT**.

- Listed individuals inside the action area may either fall into the NO EFFECT or MAY AFFECT (LIKELY or NOT LIKELY TO ADVERSELY AFFECT) categories depending upon their specific biological needs, circumstances of exposure, etc.



- LIKELY or NOT LIKELY TO ADVERSELY AFFECT determinations are made using the following criteria:
 - Insignificant - The level of the effect cannot be meaningfully related to a “take.”
 - Highly Uncertain - The effect is highly unlikely to occur.
 - Wholly beneficial - The effects are only good things.

Spray Drift Mitigation

EFED’s refined endangered species risk assessment took into account the spray drift mitigation language that has been added to the most recent proposed label submitted by the registrant. An accounting of federally-listed threatened or endangered species within the 7 states (covered in this assessment) proposed for dicamba DGA use on genetically modified cotton and soybeans is included in **Appendix 1** (307 species). Specifically, the spray drift mitigation language on the M1691 Herbicide Supplemental labels for the use dicamba DGA salt on ROUNDUP READY 2 XTEND™ soybean and BOLLGARD II® XTENDFLEX cotton includes the following limitations:

- Specifying the use of a nozzle (Tee Jet® TTI1004) with ASABE S-572 ultra-coarse and extremely coarse droplet spectra and a maximum operating pressure of 63 psi.
- A maximum equipment ground speed of 15 miles per hour and ground boom height of 24 inches above the target pest or crop canopy.
- Restricting all applications when wind speeds are < 3 mph or > 15 mph and restricting applications when wind is blowing towards sensitive areas at > 10 mph. Maintaining use of a 110 foot in-field buffer for a 0.5 lb a.i./A application (220 foot in-field buffer for a 1 lb a.i./A application) when the wind is blowing towards any areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures.
- Applications done in low relative humidity conditions are to use equipment set to produce larger droplet spectra to compensate for evaporation.
- Applications are not be conducted during temperature inversions.

- In order to prevent effects to non-target susceptible plants, the label also includes the following language: “do not apply under circumstances where spray drift may occur to food, forage or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants because severe injury or destruction may result, including plants in a greenhouse. Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from the off-target movement of M1691 Herbicide. The Applicator must survey the application site for neighboring sensitive areas prior to application. The applicator also should consult sensitive crop registries for locating sensitive areas where available.”
- Finally, in order to prevent unintended damage from the drift of M1691 Herbicide, the label says not to apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

The incorporation of the spray drift mitigation measures into the product labeling as outlined above would result in exposure to dicamba DGA from spray drift at a level where effects are expected only within the confines of the treated field and so the action area is limited to the dicamba DGA treated field. Further, the incorporation of the “susceptible plants” spray drift mitigation language on the label is to avoid damage to these plants (including adjacent crops). Because the risk assessment interprets the threshold for plant damage concern to be based on the most sensitive plant species tested and the screening level ecological risk assessment has demonstrated that these plant effects endpoints constitute the most conservative terrestrial organism levels of effect, it is concluded that the “susceptible plants” requirement requires a level of drift mitigation that would also prevent less sensitive organisms from being exposed at levels of concern. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to dicamba DGA, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any effects thresholds of concern. Additionally, as indicated in the screening level ecological risk assessments for cotton and soybean, no aquatic receptor taxa are of concern for drift or runoff exposure (LOCs were not exceeded for aquatic taxa). **Consequently, all but 14 of the listed species originally identified as potentially at-risk are determined to be given a “no effect” (NE) without further refinement because they are not expected to occur in an action area encompassing the treated soybean and cotton fields (Appendix 2).** The remaining 16 species are assessed using the refinements set forth in the 2004 Overview document referred to earlier in this assessment.

Exposure through Runoff

The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted

concentrations from modeling were lower than the most sensitive taxa's endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a "no effects" determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would also protect against the risk of exposure to listed species off the treated field.

In addition to the spray drift and runoff mitigation measures contained in the proposed labeling, EFED analyzed species-specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment. An accounting of the federally-listed threatened or endangered species within the 7 states proposed for this registration showed 307 listed species as potentially at risk (direct or indirect effects) as a result of the screening-level assessment (**Appendix 1**). The spray drift mitigation label language cannot preclude listed species being exposed to dicamba DGA salt or DCSA residues on treated fields, should a listed species utilize such areas as part of its range and corresponding habitat. Of the 307 listed species within the 7 states (AL, GA, KY, MI, NC, SC, and TX) considered part of the proposed Federal decision, the following 14 species were reasonably expected to occur on soybean and cotton fields, which could potentially be treated with dicamba and therefore could not be assumed to be "no effect" solely on the basis of occurrence outside the action area:

Of these 14 species, a "no effect" determination was reached in the concurrent assessment action for 16 states (DP 416416, 420160, 420159, 420352, 421434, 421723 covering AR, IL, IA, IN, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI) for the following species and is applicable to the additional seven states in this refined assessment as well:

- American burying beetle (*Nicrophorus americanus*)
- Gopher tortoise (*Gopherus polyphemus*)
- Indiana bat (*Myotis sodalis*)
- Lesser prairie-chicken (*Tympanuchus pallidicinctus*)
- Louisiana black bear (*Ursus americanus luteolus*)
- Whooping crane (*Grus americana*)

This leaves the following species for which the remainder of this document uses species specific biological information and dicamba DGA use patterns in more depth to further refine the assessment and effects determinations:

- Attwater's greater prairie-chicken (*Tympanuchus cupido attwateri*)
- Eskimo curlew (*Numenius borealis*)
- Eastern indigo snake (*Drymarchon corais couperi*)
- Houston toad (*Bufo houstonensis*)

- Virginia big-eared bat (*Corynorhinus (=Plecotus) townsendii virginianus*)
- Ocelot (*Leopardus (Felis) pardalis*)
- Gulf Coast jaguarundi (*Herpailurus (=Felis) yagouaroundi cacomitli*)
- Red wolf (*Canis rufus*)

Therefore, species specific biological information (e.g., body size, dietary requirements, and seasonality) and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations.

This assessment also uses the refined exposure values determined in the cotton screening level assessment and the concurrently issued addendum to the soybean screening level risk assessment documents compared to the initial exposure estimates from the soybean screening level assessment. This ESA assessment also evaluates chronic exposures from DCSA separately from the chronic exposure to parent dicamba. Dicamba exposure values were determined from the upper bound of the modeled T-REX run for exposures following spray applications based on the Kenaga nomogram modified by Fletcher *et al* (1984), which is based on a large set of actual field residue data. Modeled dicamba exposure values were identical between the soybean addendum and the cotton screening level risk assessment (since the maximum application rates and minimum application intervals are the same).

Similar modeling of DCSA residues, which are formed inside the tolerant-soybean and tolerant-cotton plants through plant metabolism, is not feasible at this time due to a lack of sufficient data tracking DCSA residues in plant tissues over time to ascertain degradation rates. Therefore, in the soybean addendum and the cotton screening-level risk assessment, EFED used the maximum empirical measured DCSA residue concentrations in dicamba-tolerant soybean (61.1 mg/kg (ppm) DCSA in broadleaf plants and 0.440 ppm in soybean seeds) and cotton plant tissues (6.29 ppm DCSA in cotton gin byproducts and 0.27 ppm in undelinted cotton seed) to evaluate chronic exposures to DCSA for animals foraging on soybean and cotton plants. Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed soybean/cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications (*i.e.* arthropod concentrations estimated to be approximately 70% of the concentrations in broadleaf plant tissues or 42.5 ppm DCSA in arthropods feeding on soybean plants and 4.4 ppm in arthropods feeding on cotton plants). The empirical residue data for cotton indicated that chronic exposures of birds and mammals to dicamba or DCSA in cotton tissues **would not** be above any levels of concern. Although the concurrently issued soybean addendum indicates that chronic risk to mammals and birds was only a concern from DCSA residues in plant/prey tissues and not from residues of parent dicamba, since the original soybean screening-level assessment (USEPA, 2011) indicated chronic risk to mammals, this assessment presents the estimated exposures and comparisons to threshold toxicity values for both dicamba and DCSA for mammals, but evaluates them separately since their chronic toxicity and exposure profiles differ greatly. For birds, following

the conclusions of the screening level assessments and the soybean addendum, only acute risk from dicamba exposures and chronic risk from DCSA exposures is evaluated.

The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Refined ecological risk assessment for the remaining species potentially exposed to dicamba residues

For the effects determinations for Attwater's prairie-chicken, eskimo curlew, Eastern indigo snake, Houston toad, Virginia big-eared bat, ocelot, Gulf Coast jaguarundi and red wolf, a refined risk assessment approach was used to evaluate additional lines of evidence to determine whether the conservative generic assumptions in the screening risk assessment apply to a particular species of interest (*e.g.* the Attwater's prairie-chicken). In the case of the prairie-chicken, the refined risk assessment investigated the impacts of more chicken specific data related to:

1. Bird size (as the chicken is smaller than the 1000g large bird category used in the initial screen)
2. Bird food consumption tailored to:
 - a. The true weight of the bird
 - b. Energy requirements of the chicken
 - c. Improvement on the generic food intake model of the screen to assess energy content of the diet and the actual free living energy requirements of a bird the size of a chicken
3. Toxicity endpoints were scaled from the weight of the tested surrogate species (bobwhite quail) to reflect the comparatively larger actual size of the Attwater's greater prairie chicken

Using the Attwater's greater prairie chicken as an example to show how EPA made its effects determinations, EPA determined that the chicken could be feeding on arthropod prey in treated cotton and soybean fields. As stated above, for acute and chronic exposures to dicamba, EPA used the upper bound predicted concentrations of dicamba DGA salt found on arthropods from T-REX modeling. For chronic exposures to DCSA residues, EPA used the maximum measured concentrations found in broadleaf plants, modified by the Kenaga relationship between broadleaf plants and arthropods. EPA used the predicted concentrations of dicamba DGA salt found on arthropods as its conservative prey analysis consistent with the preliminary risk concerns identified in the screening assessment. This prey analysis is consistent with the preliminary risk concerns identified in the screening assessments. This analysis is conservative as it assumes 1) that 100% of the chicken's food consumption comes from exposed arthropods and 2) the level of

dicamba DGA residues assumed to be on these prey arthropods is based on the upper bound Kenaga residues expected for arthropods directly exposed to spray applications of dicamba DGA and for exposure to DCSA that residues in the arthropod prey item are based on the maximum measured values in broadleaf plant tissues modified by the Kenaga relationship between residues in arthropods and broadleaf plants following spray applications. EPA determined the field metabolic rate of the prairie chicken through the use of a published peer reviewed allometric equation that relates bodyweight to energy requirements. From there the mass of prey consumed per day is determined by dividing the field metabolic rate (kcal/day) by the energy content of the arthropod prey and an assimilation factor that accounts for the ability of birds to absorb that energy from the diet. Values were obtained from a published peer reviewed EPA document produced by the Office of Research and Development for Agency-wide use in conducting ecological risk assessment (USEPA, 1993). The mass of dicamba DGA in the insect diet is determined from the T-REX run found in the addendum to the screening-level risk assessment, issued concurrently with this risk assessment (USEPA, 2016a) while the mass of DCSA in insect diet was assumed to be 42.5 ppm (70% of the maximum measured residues in soybean hay of 61.1 ppm). The mass of prey consumed per day is then multiplied by the mass of dicamba or DCSA in the insect diet to determine the mass of dicamba or DCSA in the chicken's daily diet in mg/day. Then the daily dose that the chicken (considering its bodyweight) receives is determined by multiplying the mass of dicamba or DCSA in the daily diet of arthropods (assuming that is the only food item) times the mass of prey consumed per day divided by the bodyweight of the prairie chicken. Then EPA scaled the acute toxicity endpoint (based on the tested surrogate bird species, bobwhite quail's default weight of 178 grams) to the bodyweight of the prairie chicken to determine the acute oral toxicity for the prairie chicken. For exposures to DCSA residues, the chronic toxicity endpoint for the mallard (the most sensitive tested species) was modified by the relationship between the chronic dicamba and DCSA endpoints for rats (a 17x difference). The acute RQ for dicamba exposures is then calculated by dividing the daily dose of dicamba from consuming arthropods by the acute oral toxicity endpoint while the chronic RQ is calculated by dividing the daily dose of DCSA by the chronic toxicity endpoint. In this case the acute RQ for dicamba was 0.08, which is below the endangered species level of concern of 0.1, while the chronic RQ for DCSA was 0.18, which is below the listed and non-listed species chronic LOC of 1.0. At this point, EPA was able to conclude that dicamba and its metabolite DCSA would not have an effect on the Attwater's greater prairie-chicken.

Birds

The screening-level assessments showed that birds could be at risk of mortality from acute exposures to dicamba DGA on treated fields, but chronic risk was not expected as no chronic RQs exceeded the Agency's LOC (1.0) for chronic risk (USEPA 2011. D378444, p. 15). The concurrently issued soybean addendum did indicate that chronic exposures to DCSA residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, for listed species that could reasonably be expected to occur on treated soybean and

cotton fields, EPA conducted a refined assessment for acute (dicamba only) and chronic (DCSA only, and only for soybean) exposures. Of the remaining bird species identified as potentially at acute risk in the seven states, two are reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

Attwater's greater prairie-chicken

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds indicated concerns for acute effects. The assumptions in the initial screen were adjusted to account for the prairie-chicken's biology. Attwater's prairie chickens are omnivorous, feeding on a variety of dietary items including seeds and pods, insects, broadleaf plants and grasses, with adults feeding primarily on grain, while juvenile chickens primarily consume insects. (Lehman, 1941). Therefore, at the time of post-emergent dicamba applications (late spring, summer), the most attractive dietary items in soybean and cotton fields will be waste grain from weed species and terrestrial invertebrates. As a conservative approach, EPA used the modeled upper bound T-REX residues for arthropods (which were higher than the modeled residues in grain) to evaluate the potential risk posed by dicamba applications at this time. This is considered a conservative approach as modeled residues in arthropods are higher than for the other most likely dietary items and 100% of the chicken's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. Agricultural grains are expected to have lower residues than those predicted for arthropods and other dietary items, such as broadleaf plant tissues are not expected to constitute as significant a source of the chicken's diet compared to arthropods, for juvenile chickens, or grain for adult chickens (Lehman, 1941). A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(772)^{0.749} = 166.73$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Attwater's greater prairie-chicken from US FWS Recovery Plan (USFWS, 2010);
http://ecos.fws.gov/docs/recovery_plan/100426.pdf)

Mass of prey consumed per day = $166.73 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 136.22$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USFWS, 2010, Lehman, 1941)

Mass of dicamba DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = 136.22 g/day X 102.99 mg dicamba DGA/kg-ww insect prey X 0.001 = 14.03 mg/day

Daily dose in chicken = 14.03 mg dicamba DGA/day/0.772= **18.17 mg/kg-bw/day**

Chicken LD50 mg/kg-bw = 188 mg/kg-bw X (772/178)^(1.15-1) = **234.28 mg/kg-bw**

The RQ for acute effects = 18.17/234.28 = **0.08**

An acute RQ of 0.08 does not exceed the acute LOC of 0.1. Consequently, EPA makes a “no effect” determination for the Attwater’s greater prairie chicken

DCSA Assessment for Attwater’s greater prairie chicken consuming arthropods that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the chicken’s diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. Agricultural grains are expected to have lower residues than those predicted for arthropods and other dietary items, such as broadleaf plant tissues are not expected to constitute as significant a source of the chicken’s diet compared to arthropods, for juvenile chickens, or grain for adult chickens (Lehman, 1941). A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(772)^{0.749} = 166.73$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Attwater’s greater prairie-chicken from US FWS Recovery Plan (USFWS, 2010); http://ecos.fws.gov/docs/recovery_plan/100426.pdf)

Mass of prey consumed per day = 166.73 kcal/day/(1.7 kcal/g ww X 0.72 AE) = 136.22 g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USFWS, 2010, Lehman, 1941)

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 136.22 g/day X 42.5 mg DCSA/kg-ww insect prey X 0.001
= 5.79 mg/day

Daily dose in chicken = 5.79 mg DCSA/day/0.772 = **7.50 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 7.5/40.88 = 0.18$

An RQ of 0.18 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Atwater’s greater prairie chicken.**

Eskimo curlew

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds indicated concerns for acute effects. The Eskimo curlew is a species determined to potentially occupy treated agricultural fields such as cotton and soybean fields and thus be subject to exposure to dicamba DGA on the treated field. Historically, the species’ breeding grounds were in Alaska and the Northwest Territories, Canada and overwintered in South America (USFWS, 2011a). The curlew is thought to have crossed the Gulf of Mexico into Texas during their spring migrations and preferred burned and disturbed prairie habitats and agricultural fields where they fed primarily on grasshoppers and other insects (Gill et al., 1998, USFWS, 2011a). The assumptions in the initial screen were adjusted to account for the Eskimo curlew’s biology. As a conservative approach, EPA used the modeled upper bound T-REX modeled residues for arthropods to evaluate the potential risk posed by dicamba applications at this time. This is considered a conservative approach as 100% of the Eskimo curlew’s diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(240)^{0.749} = 69.5$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Eskimo curlew from USGS, 2014 <http://www.npwrc.usgs.gov/resource/birds/curlew/identif.htm>)

Mass of prey consumed per day = $69.5 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 56.8$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USGS 2014)

Mass of dicamba DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = 56.8 g/day X 102.99 mg dicamba DGA/kg-ww insect prey X 0.001 = 5.85 mg/day

Daily dose in curlew = 5.85 mg dicamba DGA/day/0.24 = **24.37 mg/kg-bw/day**

Curlew LD50 mg/kg-bw = 188 mg/kg-bw X (240/178)^(1.15-1) = **196.6 mg/kg-bw**

The RQ for acute effects = 24.37/196.6 = **0.12**

An acute RQ of 0.12 exceeds the acute LOC of 0.1.

DCSA Assessment Eskimo curlew consuming arthropods that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the curlew's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(240)^{0.749}$ = 69.5 kcal/day
(USEPA 1993, body weight reflects screening assumption for the Eskimo curlew from USGS, 2014 <http://www.npwrc.usgs.gov/resource/birds/curlew/identif.htm>)

Mass of prey consumed per day = 69.5 kcal/day/(1.7 kcal/g ww X 0.72 AE) = 56.8 g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USGS 2014)

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 56.8 g/day X 42.5 mg DCSA/kg-ww insect prey X 0.001 = 2.41 mg/day

Daily dose in chicken = 2.41 mg DCSA/day/0.240 = **10.06 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 10.06/40.88 = 0.25$

An RQ of 0.25 does not exceed the chronic LOC of 1.0

As the analysis above concluded that exposures to the curlew from dicamba had potential to be above the acute level of concern, the assessment was further refined by using of the Terrestrial Investigation Model (TIM) to quantify the potential risks of dicamba DGA to the Eskimo curlew. The model was parameterized with two assumptions about the frequency of time they would spend on the field (frequency on field: FOF): 10 percent and 90 percent. These assumptions reflect the overall uncertainty of how much time in a given migration period the birds would encounter a feeding opportunity on crop land. The model simulated a three-day stopover in agricultural land during the early pre-emergence herbicide application season to simulate feeding during migration. The food uptake was raised to a 3X daily intake rate to simulate migratory gorging behavior. The results indicated a 5.4-94% chance of mortality to one or more Eskimo curlews (**Table 4**). The dominant route of exposure that contributes to mortality is through diet (**Table 5**). The input parameters used in this model run are included in **Appendix 3**.

Table 4. Risk of dicamba exposure to individual Eskimo curlew.

Mean FOF (%)	% Chance of mortality to one or more birds
10	5.4
90	94

Table 5. Relative contributions of exposure routes to lethal doses in simulated birds. Mean (and standard deviation) values provided.

Exposure route*	10% FOF	90% FOF
Food	93 (6.6)	84 (7.5)
Drinking water: Puddles	0	0
Drinking water: Dew	0	0
Dermal Contact	6.8 (6.6)	16 (7.5)

*Inhalation and direct spray routes of exposure were turned off.

Given the predicted chance of individual mortalities, it might be reasonable to expect effects if Eskimo curlews encountered treat fields. Known occurrences of the species span Galveston County in Texas and 23 counties in Nebraska: Nuckolls, Jefferson, Saline, Polk, Wayne, Pierce, Platte, Boone, Madison, Antelope, Merrick, Stanton, Fillmore, York, Seward, Clay, Cedar, Thayer, Hamilton, Nance, Knox, Colfax, and Butler. See Appendix 4 for range and land cover analysis.

However, the species by all accounts is extremely rare. The U.S. Fish and Wildlife Service summarized curlew numbers in a recent Biological Opinion (USFWS 2012a) for the rodenticide chlorophacinone:

Recent quantitative methods used to evaluate the probability of the Eskimo curlew's existence have estimated extinction dates of 1967 and 1965, respectively, with the upper bounds of 95 percent confidence intervals in 1977 and 1970 (Elphick et al. 2010, FWS 2011e). These estimates are based on the last uncontroversial record of observance, a specimen that was shot in Barbados in 1963 (FWS 2011e). From 1963 to the spring of 2009, 39 potential sightings have occurred in 22 different years (Committee on the Status of Endangered Wildlife in Canada 2009); however, the reliability of these sightings is variable, and none have been confirmed by physical evidence (FWS 2011e). If controversial records of observance are included, then the analysis estimates an extinction date of 2008 with the upper bound of 95 percent confidence interval reaching 2013 (FWS 2011e).

In the case of chlorophacinone, EPA had initially made a “likely to adversely affect” determination for the curlew based on direct acute effects. This pesticide application involved potential large geographic areas of rangeland habitat, likely more favorable to curlews than maintained agricultural fields. The conclusion of the Biological Opinion was:

Eskimo curlews are likely already extinct or at best extremely rare; thus, direct and indirect effects from Rozol exposure are so highly unlikely to occur as to be considered discountable. Therefore, the Service does not anticipate adverse effects to Eskimo curlew from use of Rozol on BTPDs. No critical habitat for the Eskimo curlew has been designated; therefore none will be affected.

It is reasonable to reach a similar conclusion with dicamba DGA, a compound of likely lower acute toxic hazard than chlorophacinone and proposed for use on land cover more marginal for curlews than the chlorophacinone case. **Therefore the Agency determines that the proposed labeled use of dicamba DGA is “not likely to adversely affect” (NLAA) the Eskimo curlew because exposures are so highly unlikely to occur as to be considered discountable.**

EPA informally consulted with the U.S. Fish and Wildlife Service on the NLAA effects determination made for the Eskimo Curlew. The concurrence memo is appended in Appendix 6.

Herpifauna

Using birds as a surrogate for reptiles and terrestrial-phase amphibians, consistent with the Overview document (USEPA, 2004), the screening level assessment suggests that reptiles and terrestrial-phase amphibians could be at risk of effects from acute exposures to dicamba DGA or chronic exposures to DCSA on treated fields. Of the reptile and amphibian species identified as

potentially at acute risk in the seven states, one reptile and one amphibian are reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

Eastern Indigo snake

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds/reptiles indicated concerns for acute effects to reptiles (using birds as a surrogate). The Eastern Indigo Snake is known or believed to occur in Alabama, Florida and Georgia (USFWS Species Profile Page, http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=C026). In Georgia, the species has been observed moving from sandhill habitat to the vicinity of agricultural fields in summer (Speake et al., 1978). Therefore, the species was determined to potentially occupy treated cotton and soybean fields and thus be subject to exposure to dicamba DGA on the treated field. The indigo snake feeds largely on other snakes, small tortoises, small mammals, and amphibians (USFWS, 1983). Using the conservative assumptions that the prey species is represented by a 35g mammal that feeds exclusively on contaminated short grass receiving the upper bound Kenaga residues from the spray application of dicamba and that the snake exclusively feeds on this prey species, the assumptions in the initial screen were adjusted to account for the indigo snake's biology:

Field metabolic rate kcal/day = $0.0530(4300)^{0.799} = 42.4$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the indigo snake from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $42.4 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.78 \text{ AE}) = 32 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.78 is assimilation efficiency from USEPA 1993, assumption of small mammal prey from the recovery plan (USFWS, 1983) and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013).

Mass of dicamba DGA in a 35-g mammal diet 173.26 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $32 \text{ g/day} \times 173.26 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 5.54 \text{ mg/day}$

Daily dose in snake = $5.54 \text{ mg dicamba DGA/day} / 4.3 = 1.29 \text{ mg/kg-bw/day}$

Appropriate scaling factors are not available for reptiles and amphibians so the acute toxicity value for the bobwhite quail (most sensitive avian species for which acute data are available) serves as a surrogate (USEPA, 2004) toxicity value for the tortoise:

Snake LD50 mg/kg-bw = **188 mg/kg-bw**

The RQ for acute effects = $1.29/188 = 0.007$

An acute RQ of 0.007 does not exceed the acute listed species LOC of 0.1. **Consequently, EPA makes a “no effect” determination for the indigo snake.**

DCSA Assessment for Eastern indigo snake consuming prey that had previously consumed soybean forage

The indigo snake feeds largely on other snakes, small tortoises, small mammals, and amphibians (USFWS, 1983). Using the conservative assumptions that the prey species is represented by a mammal that feeds exclusively on exposed soybean plant tissue containing the maximum measured DCSA residues of 61.1 ppm and that the snake exclusively feeds on this prey species, the assumptions in the initial screen were adjusted to account for the indigo snake's biology:

Field metabolic rate kcal/day = $0.0530(4300)^{0.799} = 42.4$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the indigo snake from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $42.4 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.78 \text{ AE}) = 32 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.78 is assimilation efficiency from USEPA 1993, assumption of small mammal prey from the recovery plan (USFWS, 1983) and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013).

Mass of DCSA in a mammal diet 61.1 mg/kg-ww (maximum empirical residue data on soybean forage)

Mass of DCSA in snake's daily diet = $32 \text{ g/day} \times 61.1 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 1.96 \text{ mg DCSA/day}$

Daily dose in snake = $1.96 \text{ mg DCSA/day} / 4.3 = 0.46 \text{ mg/kg-bw/day}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck (surrogate species for reptiles) study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 0.46/40.88 = 0.01$

An RQ of 0.01 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Eastern indigo snake.**

Houston toad

Initial screening level risk assessment results for birds/terrestrial-phase amphibians indicated concerns for acute effects to amphibians (using birds as a surrogate). Historically, Houston toads ranged across the central coastal region of Texas in grassland/prairie ecosystems or in or near forested habitat and metamorphosed adult toads likely eat small terrestrial arthropods (USFWS, 2011b). As a conservative approach, EPA used the modeled upper bound T-REX residues for arthropods to evaluate the potential risk posed by dicamba applications at this time. This is considered a conservative approach as 100% of the toad's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $0.0530(45)^{0.799} = 1.1$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Houston toad from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $1.1 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 0.9 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, insect diet assumption from USFWS, 2011b and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of dicamba DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $0.9 \text{ g/day} \times 102.99 \text{ mg dicamba DGA/kg-ww insect prey} \times 0.001 = 0.09 \text{ mg/day}$

Daily dose in toad = $0.09 \text{ mg dicamba DGA/day} / 0.045 = \mathbf{2.06 \text{ mg/kg-bw/day}}$

$$\text{Toad LD50 mg/kg-bw} = 188 \text{ mg/kg-bw} \times (45/178)^{(1.15-1)} = \mathbf{152.96 \text{ mg/kg-bw}}$$

(assumes the same scaling as for birds)

$$\text{The RQ for acute effects} = 2.06/152.96 = \mathbf{0.01}$$

An acute RQ of 0.01 does not exceed the acute listed species LOC of 0.1. **Consequently, EPA makes a “no effect” determination for the Houston toad.**

DCSA Assessment for Houston toad consuming prey that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as 100% of the toad's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $0.0530(45)^{0.799} = 1.1 \text{ kcal/day}$
 (USEPA 1993, body weight reflects screening assumption for the Houston toad from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $1.1 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 0.9 \text{ g/day}$
 (1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, insect diet assumption from USFWS, 2011b and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = $0.9 \text{ g/day} \times 42.5 \text{ mg dicamba DGA/kg-ww insect prey} \times 0.001 = 0.038 \text{ mg/day}$

Daily dose in toad = $0.038 \text{ mg DCSA/day} / 0.045 = \mathbf{0.85 \text{ mg/kg-bw/day}}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck (surrogate species for terrestrial-phase amphibians) study for parent dicamba) modified by ratio of parent

dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of 40.88 mg/kg-diet.

RQ for chronic exposure: $RQ = 0.85/40.88 = 0.02$

An RQ of 0.02 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Houston toad.**

Mammals

The screening-level assessments indicated that acute risk to mammals was not expected as no acute RQs exceeded the Agency’s LOC (0.1) for acute risk (USEPA 2011. D378444, p. 15). However, the soybean screening-level assessment (USEPA, 2011) indicated that mammals could be at reproductive risk from chronic exposures to dicamba DGA on treated fields, though the cotton screening level and concurrently issued soybean addendum (USEPA, 2016a and USEPA, 2016b) indicated that chronic exposures to dicamba DGA would be below the chronic LOC (1.0). This difference is due to soybean screening level risk assessment’s use of a chronic endpoint from the rat 2-generation study (MRID 43137101), of 45 mg/kg-bw for the NOAEL, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016c; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, as pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. Therefore, the cotton screening level risk assessment, the concurrently issued soybean addendum and this refined endangered species risk assessment use this revised NOAEL for dicamba DGA salt.

The concurrently issued soybean addendum did indicate that chronic exposures to dicamba’s metabolite, DCSA, residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency’s LOC for chronic risk. Therefore, EPA only conducted a refined assessment for chronic exposures to DCSA in soybeans for listed species that could reasonably be expected to occur on treated soybean fields.

Of the mammalian species identified as potentially at risk in the seven states, four are reasonably expected to occur on treated soybean fields. Species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for the four species potentially expected to occur on treated soybean fields.

Virginia big-eared bat

Dicamba Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects to mammals. This bat is assumed to potentially forage over treated fields and thus be subject to exposure to dicamba DGA on the treated field. Big-eared bats feed principally on small moths and other insects (USFWS, 1984). Exposure assumptions from the screening assessment were refined to account for the Virginia big-eared bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods having received the upper bound Kenaga residues from the spray application of dicamba.

Field metabolic rate kcal/day = $0.6167(7\text{g})^{0.862} = 3.3 \text{ kcal/day}$
(USEPA 1993, body weight 7 g reflects screening assumption for the bat USFWS 2014a;
<http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A080>)

Mass of prey consumed per day = $(3.3 \text{ kcal/day}) / (1.7 \text{ kcal/g ww} \times 0.87 \text{ AE}) = 2.2 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.87 is assimilation efficiency from USEPA 1993)

Mass of dicamba DGA in insect diet = 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $2.2 \text{ g/day} \times 102.99 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 0.23 \text{ mg/day}$

Daily dose in bat = $0.23 \text{ mg dicamba DGA/day} / 0.007 \text{ kg} = \mathbf{32.37 \text{ mg/kg-bw/day}}$

Bat NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/7)^{0.25} = \mathbf{361.64 \text{ mg/kg-bw}}$

RQ for chronic exposure = $\text{RQ} = 32.37 / 361.64 = \mathbf{0.09}$

A chronic RQ of 0.09 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the the Virginia big-eared bat.**

DCSA Assessment for Virginia big-eared bat consuming prey that had previously consumed soybean forage

Initial screening level risk assessment results for the Virginia big-eared bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods feeding on dicamba-tolerant soybean plant tissues that had the highest measured DCSA residues.

Field metabolic rate kcal/day = $0.6167(7\text{g})^{0.862} = 3.3 \text{ kcal/day}$

(USEPA 1993, body weight 7 g reflects screening assumption for the bat USFWS 2014a; <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?scode=A080>)

Mass of prey consumed per day = (3.3 kcal/day)/(1.7 kcal/g ww X 0.87 AE) = 2.2 g/day (1.7 is energy content of prey item from USEPA (1993); 0.87 is assimilation efficiency from USEPA 1993)

Mass of DCSA in insect diet = 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 2.2 g/day X 42.5 mg DCSA/kg-ww mammal prey X 0.001 = 0.094 mg/day

Daily dose in bat = 0.094 mg DCSA/day/0.007 kg = **13.357 mg/kg-bw/day**

Bat NOAEL mg/kg-bw/day = 8 mg/kg-bw X (350/7)^{0.25} = **21.27 mg/kg-bw**

RQ for chronic exposure = RQ = 13.357/21.27 = **0.63**

A chronic RQ of 0.63 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Virginia big-eared bat.**

Ocelot

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects to mammals. The recovery plan for the ocelot (USFWS, 1990, revised 2010) describes the ocelot's habitat in Texas as dense thornscrub communities on Laguna Atascosa National Wildlife Refuge and on private lands in three Texas counties. The ocelot requires dense vegetation (>75% canopy cover), with 95% cover of the shrub layer preferred in Texas and it feeds primarily on rabbits, rodents, birds and lizards (USFWS, 1990). Although this indicates the ocelot is unlikely to inhabit agricultural row crop areas, the prey species it feeds on could be exposed in soybean or cotton fields and then subsequently consumed by the ocelot away from the field. Using the assumption that the prey species is represented by a 1000 g mammal (conservative as to rabbits) and using the conservative assumptions that the prey feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for ocelot's biology:

Field metabolic rate kcal/day = $0.6167(16000)^{0.862} = 2594$ kcal/day

(USEPA 1993, body weight reflects screening assumption for the ocelot from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of prey consumed per day = $2594 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 1816 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, mammal diet assumption from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of dicamba DGA in 1kg mammal diet 40.17 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $1816 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 72.95 \text{ mg/day}$

Daily dose in ocelot = $72.95 \text{ mg dicamba DGA/day} / 16 = \mathbf{4.56 \text{ mg/kg-bw/day}}$

Ocelot NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} (350/16000)^{(0.25)} = \mathbf{52.30 \text{ mg/kg-bw}}$

The RQ for chronic effects = $4.56/52.30 = \mathbf{0.09}$

A chronic RQ of 0.09 does not exceed the chronic LOC of 1.0. Even if the ocelot were assumed to consume a smaller (35-g mammal) prey species that had consumed exposed short grass (T-REX modeled residues of 173.26 mg/kg-ww), the chronic RQ (0.38) would still be below the LOC. **Consequently, EPA makes a “no effect” determination for the ocelot.**

DCSA Assessment for Ocelot consuming prey that had previously consumed exposed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56 \text{ g/day}$

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8 \text{ g/day}$

DCSA residue in prey eating soybean forage/hay $61.1 \text{ mg DCSA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{9.34 \text{ mg/kg-bw/day}}$

The next step is to determine the expected daily dose for a typical 16 kg ocelot, the adjusted NOAEL value and the chronic dose-based RQ for the ocelot based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(16000)^{0.862} = 2594$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the ocelot from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of prey consumed per day = $2594 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 1816$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, mammal diet assumption from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of DCSA in 1kg mammal diet 9.34 mg/kg-ww (based on allometric equations above and maximum empirical residue data on soybean forage)

Mass of DCSA in daily diet = $1816 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 16.96$ mg/day

Daily dose in ocelot = $16.96 \text{ mg DCSA/day} / 16 = 1.060$ mg/kg-bw/day

Ocelot NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} (350/16000)^{(0.25)} = 3.08$ mg/kg-bw

The RQ for chronic effects = $1.06/3.08 = 0.35$

A chronic RQ of 0.35 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “No Effect” determination for the ocelot.**

Gulf Coast jaguarundi

Initial screening level risk assessment results for mammals identified concerns for chronic effects. The recovery plan for the jaguarundi (USFWS, 2012b) describes the species as using dense thorny shrublands or woodlands and bunchgrass pastures adjacent to dense brush or woody cover and preying mainly on birds, small mammals, and reptiles. Although this indicates the jaguarundi is unlikely to inhabit agricultural row crop areas, the prey species it feeds on could be exposed in soybean or cotton fields and then subsequently consumed by the jaguarundi away from the field. Using the assumptions that the prey species is represented by a 1000 g mammal and using the conservative assumptions that the prey feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba,

exposure assumptions from the screening assessment were adjusted to account for the jaguarundi's biology:

Field metabolic rate kcal/day = $0.6167(90000)^{0.862} = 11498$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguarundi from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of prey consumed per day = $11498 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 8051$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of dicamba DGA in 1 kg mammal diet 40.17 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $8051 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 323 \text{ mg/day}$

Daily dose in jaguarundi = $323 \text{ mg dicamba DGA/day} / 90 = \mathbf{3.59 \text{ mg/kg-bw/day}}$

Jaguarundi NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/90000)^{(0.25)} = \mathbf{33.96 \text{ mg/kg-bw}}$

The RQ for chronic effects = $3.59/33.96 = \mathbf{0.11}$.

A chronic RQ of 0.11 does not exceed the chronic LOC of 1.0. Even if the jaguarundi were assumed to consume a smaller (35-g mammal) prey species that had consumed exposed short grass (T-REX modeled residues of 173.26 mg/kg-ww), the chronic RQ (0.46) would still be below the LOC. **Consequently, EPA makes a “no effect” determination for the jaguarundi.**

DCSA Assessment for Jaguarundi consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56 \text{ g/day}$

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 90 kg jaguarundi, the adjusted NOAEL value and the chronic dose-based RQ for the ocelot based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(90000)^{0.862} = 11498$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguarundi from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of prey consumed per day = $11498 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 8051$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of DCSA in 1 kg mammal diet 9.34 mg/kg-ww (based on allometric equations above and maximum empirical DCSA residues on soybean forage)

Mass of DCSA in daily diet = $8051 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 75.20$ mg/day

Daily dose in jaguarundi = $75.20 \text{ mg DCSA/day} / 90 = \mathbf{0.84 \text{ mg/kg-bw/day}}$

Jaguarundi NOAEL mg/kg-bw/day = $4 \text{ mg/kg-bw} \times (350/90000)^{(0.25)} = \mathbf{2.00 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.84/2.00 = \mathbf{0.42}$.

A chronic RQ of 0.42 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the jaguarundi.**

Red wolf

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Since 1987, reintroduced red wolves have been identified in a variety of habitats including wetlands, pine forests, upland shrubs, and cropland (USFWS, 2007). The diet of red

wolves is primarily white-tailed deer, but they may also eat smaller mammals such as raccoons, rabbits and mice (Whitaker and Hamilton, 1998). Using the conservative assumptions that the prey species is represented by a 1000 g mammal (conservative for deer, raccoons and rabbits) that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the red wolf's biology, specifically their consumption of other mammals that may have been exposed to dicamba DGA residues in cotton and soybean fields.

Field metabolic rate kcal/day = $0.6167(36000)^{0.862} = 5219$ kcal/day (USEPA 1993, body weight reflects screening assumption for the red wolf from Whitaker and Hamilton (1998))

Mass of prey consumed per day = $5219 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 3654$ g/day (1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Whitaker and Hamilton (1998))

Mass of dicamba DGA in 1 kg mammal diet 40.17 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $3654 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 147$ mg/day

Daily dose in wolf = $147 \text{ mg dicamba DGA/day} / 36 = 4.08$ mg/kg-bw/day

Wolf NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/36000)^{(0.25)} = 42.71$ mg/kg-bw

The RQ for chronic effects = $4.08/42.71 = 0.10$.

A chronic RQ of 0.10 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the red wolf.**

DCSA Assessment for red wolf consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56$ g/day

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 36 kg wolf, the adjusted NOAEL value and the chronic dose-based RQ for the wolf based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(36000)^{0.862}$ = 5219 kcal/day (USEPA 1993, body weight reflects screening assumption for the red wolf from Whitaker and Hamilton (1998))

Mass of prey consumed per day = 5219 kcal/day/(1.7 kcal/g ww X 0.84 AE) = 3654 g/day (1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Whitaker and Hamilton (1998))

Mass of DCSA in 1 kg mammal diet 9.34 mg/kg-ww from allometric equations above and maximum empirical residue data.

Mass of DCSA in daily diet = 3654 g/day X 9.34 mg DCSA/kg-ww mammal prey X 0.001 = 34.13 mg/day

Daily dose in wolf = 34.13 mg dicamba DGA/day/36 = **0.95 mg/kg-bw/day**

Wolf NOAEL mg/kg-bw/day = 8 mg/kg-bw X $(350/36000)^{(0.25)}$ = **2.51 mg/kg-bw**

The RQ for chronic effects = 0.95/2.51 = **0.38**

A chronic RQ of 0.38 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the red wolf.**

Critical Habitat Determinations

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis consistent with the Overview Document as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife Service or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species. The Agency will conclude 'modification' of designated critical habitat if the range of designated critical habitat co-occurs with the states subject to the Federal action and one or more of the following conditions exist:

1. The available Services' information indicates that cotton or soybean fields are habitat for the species and there is a "may affect" determination for the species associated with exposure to dicamba DGA salt or its degradate, DCSA, as labeled.
2. The available Services' information indicates that the species uses cotton or soybean fields and one or more effects on taxonomic groups predicted for dicamba DGA salt or its degradate DCSA, on cotton and soybean fields would modify one or more of the designated PCEs.

If neither of the above conditions are met, EPA concludes "no modification."

Results of Analysis

Of the 307 listed species within the states, there are 292 species identified in the effects determinations as not using cotton or soybean fields and 14 species using these fields (**Appendix 5**). Critical habitats have been designated for 118 of the 307 species. One-hundred thirteen (113) species with critical habitat were judged to not use cotton or soybean fields and so the critical habitat determination for these was "no modification."

The remaining 5 species with critical habitat designations were assumed to use cotton or soybean fields and so the previous listed species effects determinations were consulted to ascertain if any were determined to be at risk for direct adverse effects. None of the species were determined to be at risk for direct adverse effects, so the PCE's listed in the Services' critical habitat designations were consulted to determine if, in light of the screening assessment risk findings, they would be impacted by on-field exposure to dicamba DGA salt. For all but one of these species, the PCE's are not relatable to agricultural fields and so a determination of no modification has been made for these 4 species.

The only remaining species using cotton or soybean fields and with critical habitat PCE's relatable to agricultural fields was the whooping crane, for which agricultural fields were discussed as providing waste grain as a potential food source for migratory cranes. The only way the proposed dicamba DGA salt could affect this PCE is by making grain potentially toxic to the birds. As there is unlikely to be any edible waste grain remaining following cotton harvesting, it is unlikely that the proposed dicamba DGA salt use on cotton could affect this PCE, however the proposed use on soybean could affect this PCE by making waste soybean grain potentially toxic.

The Health Effects Division summarized available soybean grain residues of dicamba in the Human Health Risk Assessment for the Registration Eligibility Decision for Dicamba and Associated Salts (DP317703). Based on the soybean trials results, maximum residues of dicamba were 0.04 ppm in hay, 0.097 ppm in forage, and 8.13 ppm in seed 6-8 days post treatment (MRIDs 43814101 and 44089307). These measured values were used to set the tolerance value of 10 ppm for soybean seeds. The measured residues are not reasonably expected to be at a level

raising a concern for direct effects to the whooping crane because the direct effects assessment for this species (presented in the Section 3 Risk Assessment Refined Endangered Species Assessment that assessed risks to endangered species in 16 states (Arkansas, Kansas, Louisiana, Illinois, Indiana, Iowa, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin {DP 416416, 420160, 420159, 420352, 421434, 421723})) did not establish a concern for residues in other dietary items at much **higher** (~ 1 order of magnitude) concentrations than would occur at the maximum measured residues in seed or if residues were present even at the tolerance level of 10.0 ppm. Because this analysis shows no direct effects of dicamba at levels that would be expected in the fields as waste grain, an indirect effect, there is no modification of critical habitat. Similarly, measured DCSA residues in waste soybean grain (0.44 ppm) would be well below the estimated DCSA concentrations in arthropods (42.5 ppm) used in the direct effects assessment for this species (D416516+, pp. 9-10). Therefore, whooping crane critical habitat within the 7 states covered in this assessment would not be modified.

Summary of Determinations for Critical Habitat

The Agency has determined that the proposed labeled use of dicamba DGA salt on cotton and soybeans will not modify designated critical habitat for all 118 species for which such habitats have been designated in AL, GA, KY, MI, NC, SC, and TX.

A summary of listed species identified as not being on agricultural fields with and without critical habitat designations for the seven states assessed for dicamba DGA salt is provided in **Appendix 5**.

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Appendix 1

Threatened and Endangered Species in Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas

Common Name	Scientific Name	Taxon
Indiana bat	<i>Myotis sodalis</i>	Mammal
West Indian Manatee	<i>Trichechus manatus</i>	Mammal
Finback whale	<i>Balaenoptera physalus</i>	Mammal
Humpback whale	<i>Megaptera novaeangliae</i>	Mammal
Gray bat	<i>Myotis grisescens</i>	Mammal
Canada Lynx	<i>Lynx canadensis</i>	Mammal
Louisiana black bear	<i>Ursus americanus luteolus</i>	Mammal
Carolina northern flying squirrel	<i>Glaucomys sabrinus coloratus</i>	Mammal
Whooping crane	<i>Grus americana</i>	Bird
Eskimo curlew	<i>Numenius borealis</i>	Bird
Kirtland's Warbler	<i>Setophaga kirtlandii</i>	Bird
Red-cockaded woodpecker	<i>Picoides borealis</i>	Bird
Wood stork	<i>Mycteria americana</i>	Bird
Piping Plover	<i>Charadrius melodus</i>	Bird
Least tern	<i>Sterna antillarum</i>	Bird
Black-capped Vireo	<i>Vireo atricapilla</i>	Bird
Lesser Prairie-Chicken	<i>Tympanuchus pallidicinctus</i>	Bird
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Reptile
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Reptile
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Reptile
Green sea turtle	<i>Chelonia mydas</i>	Reptile
Alabama red-belly turtle	<i>Pseudemys alabamensis</i>	Reptile
Copperbelly water snake	<i>Nerodia erythrogaster neglecta</i>	Reptile
Gopher tortoise	<i>Gopherus polyphemus</i>	Reptile
Snail darter	<i>Percina tanasi</i>	Fish
Spotfin Chub	<i>Erimonax monachus</i>	Fish
Slackwater darter	<i>Etheostoma boschungii</i>	Fish
Gulf sturgeon	<i>Acipenser oxyrinchus desotoi</i>	Fish
Amber darter	<i>Percina antesella</i>	Fish
Conasauga logperch	<i>Percina jenkinsi</i>	Fish
Blackside dace	<i>Phoxinus cumberlandensis</i>	Fish
Boulder darter	<i>Etheostoma wapiti</i>	Fish
Cumberland darter	<i>Etheostoma susanae</i>	Fish
Arkansas River shiner	<i>Notropis girardi</i>	Fish
Blue shiner	<i>Cyprinella caerulea</i>	Fish
Smalleye Shiner	<i>Notropis buccula</i>	Fish
Pallid sturgeon	<i>Scaphirhynchus albus</i>	Fish
Duskytail darter	<i>Etheostoma percnurum</i>	Fish
Cumberland bean (pearlymussel)	<i>Villosa trabalis</i>	Bivalve

purple cat's paw (=purple cat's paw pearlymussel)	<i>Epioblasma obliquata obliquata</i>	Bivalve
Alabama lampmussel	<i>Lampsilis virescens</i>	Bivalve
Pale lilliput (pearlymussel)	<i>Toxolasma cylindrellus</i>	Bivalve
Cumberland monkeyface (pearlymussel)	<i>Quadrula intermedia</i>	Bivalve
Pink mucket (pearlymussel)	<i>Lampsilis abrupta</i>	Bivalve
Dromedary pearlymussel	<i>Dromus dromas</i>	Bivalve
Littlewing pearlymussel	<i>Pegias fabula</i>	Bivalve
White wartyback (pearlymussel)	<i>Plethobasus cicatricosus</i>	Bivalve
Finerayed pigtoe	<i>Fusconaia cuneolus</i>	Bivalve
Rough pigtoe	<i>Pleurobema plenum</i>	Bivalve
Shiny pigtoe	<i>Fusconaia cor</i>	Bivalve
Orangefoot pimpleback (pearlymussel)	<i>Plethobasus cooperianus</i>	Bivalve
Fat pocketbook	<i>Potamilus capax</i>	Bivalve
Spectaclecase (mussel)	<i>Cumberlandia monodonta</i>	Bivalve
Southern combshell	<i>Epioblasma penita</i>	Bivalve
Rayed Bean	<i>Villosa fabalis</i>	Bivalve
Clubshell	<i>Pleurobema clava</i>	Bivalve
Cumberlandian combshell	<i>Epioblasma brevidens</i>	Bivalve
Appalachian elktoe	<i>Alasmidonta raveneliana</i>	Bivalve
Alabama (=inflated) heelsplitter	<i>Potamilus inflatus</i>	Bivalve
Orangenacre mucket	<i>Lampsilis perovalis</i>	Bivalve
Oyster mussel	<i>Epioblasma capsaeformis</i>	Bivalve
Slabside Pearlymussel	<i>Pleuroaia dolabelliformis</i>	Bivalve
Stirrupshell	<i>Quadrula stapes</i>	Bivalve
Fanshell	<i>Cyprogenia stegaria</i>	Bivalve
Finelined pocketbook	<i>Lampsilis altalis</i>	Bivalve
Northern riffleshell	<i>Epioblasma torulosa rangiana</i>	Bivalve
Ovate clubshell	<i>Pleurobema perovatum</i>	Bivalve
Southern clubshell	<i>Pleurobema decisum</i>	Bivalve
Triangular Kidneyshell	<i>Ptychobranhus greenii</i>	Bivalve
Alabama moccasinshell	<i>Medionidus acutissimus</i>	Bivalve
Coosa moccasinshell	<i>Medionidus parvulus</i>	Bivalve
Southern pigtoe	<i>Pleurobema georgianum</i>	Bivalve
Snuffbox mussel	<i>Epioblasma triquetra</i>	Bivalve
Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	Bivalve
Georgia pigtoe	<i>Pleurobema hanleyianum</i>	Bivalve
Fluted kidneyshell	<i>Ptychobranhus subtentum</i>	Bivalve
Sheepnose Mussel	<i>Plethobasus cyphus</i>	Bivalve
Anthony's riversnail	<i>Athearnia anthonyi</i>	Gastropod
Karner blue butterfly	<i>Lycaeides melissa samuelis</i>	Insect
Mitchell's satyr Butterfly	<i>Neonympha mitchellii mitchellii</i>	Insect
American burying beetle	<i>Nicrophorus americanus</i>	Insect
Hine's emerald dragonfly	<i>Somatochlora hineana</i>	Insect
Spruce-fir moss spider	<i>Microhexura montivaga</i>	Arachnid

Short's bladderpod	<i>Physaria globosa</i>	Dicot
Price's potato-bean	<i>Apios priceana</i>	Dicot
Braun's rock-cress	<i>Arabis perstellata</i>	Dicot
Cumberland rosemary	<i>Conradina verticillata</i>	Dicot
No common name	<i>Geocarpum minimum</i>	Dicot
Spreading avens	<i>Geum radiatum</i>	Dicot
Small whorled pogonia	<i>Isotria medeoloides</i>	Monocot
Short's goldenrod	<i>Solidago shortii</i>	Dicot
Cumberland sandwort	<i>Arenaria cumberlandensis</i>	Dicot
Pitcher's thistle	<i>Cirsium pitcheri</i>	Dicot
Leafy prairie-clover	<i>Dalea foliosa</i>	Dicot
Roan Mountain bluet	<i>Hedyotis purpurea</i> var. <i>montana</i>	Dicot
Dwarf lake iris	<i>Iris lacustris</i>	Monocot
Pondberry	<i>Lindera melissifolia</i>	Dicot
Eastern prairie fringed orchid	<i>Platanthera leucophaea</i>	Monocot
Harperella	<i>Ptilimnium nodosum</i>	Dicot
American chaffseed	<i>Schwalbea americana</i>	Dicot
Large-flowered skullcap	<i>Scutellaria montana</i>	Dicot
Blue Ridge goldenrod	<i>Solidago spithamea</i>	Dicot
Tennessee yellow-eyed grass	<i>Xyris tennesseensis</i>	Monocot
Virginia spiraea	<i>Spiraea virginiana</i>	Dicot
Running buffalo clover	<i>Trifolium stoloniferum</i>	Dicot
Lakeside daisy	<i>Hymenoxys herbacea</i>	Dicot
Morefield's leather flower	<i>Clematis morefieldii</i>	Dicot
Whorled Sunflower	<i>Helianthus verticillatus</i>	Dicot
American hart's-tongue fern	<i>Asplenium scolopendrium</i> var. <i>americanum</i>	Ferns
Louisiana quillwort	<i>Isoetes louisianensis</i>	Ferns
Rock gnome lichen	<i>Gymnoderma lineare</i>	Lichen
Red wolf	<i>Canis rufus</i>	Mammal
North Atlantic Right Whale	<i>Eubalaena glacialis</i>	Mammal
Sperm whale	<i>Physeter catodon</i> (= <i>macrocephalus</i>)	Mammal
Gulf Coast jaguarundi	<i>Herpailurus</i> (= <i>Felis</i>) <i>yagouaroundi cacomitli</i>	Mammal
Virginia big-eared bat	<i>Corynorhinus</i> (= <i>Plecotus</i>) <i>townsendii virginianus</i>	Mammal
Ocelot	<i>Leopardus</i> (= <i>Felis</i>) <i>pardalis</i>	Mammal
Perdido Key beach mouse	<i>Peromyscus polionotus trissyllepsis</i>	Mammal
Alabama beach mouse	<i>Peromyscus polionotus ammobates</i>	Mammal
Mexican long-nosed bat	<i>Leptonycteris nivalis</i>	Mammal
Attwater's greater prairie-chicken	<i>Tympanuchus cupido attwateri</i>	Bird
Bachman's warbler (=wood)	<i>Vermivora bachmanii</i>	Bird
Northern aplomado falcon	<i>Falco femoralis septentrionalis</i>	Bird
Mexican spotted owl	<i>Strix occidentalis lucida</i>	Bird
Roseate tern	<i>Sterna dougallii dougallii</i>	Bird

Golden-cheeked warbler (=wood)	<i>Dendroica chrysoparia</i>	Bird
Southwestern willow flycatcher	<i>Empidonax traillii extimus</i>	Bird
Loggerhead sea turtle	<i>Caretta caretta</i>	Reptile
Flattened musk turtle	<i>Sternotherus depressus</i>	Reptile
Eastern indigo snake	<i>Drymarchon corais couperi</i>	Reptile
Texas blind salamander	<i>Typhlomolge rathbuni</i>	Amphibian
Houston toad	<i>Bufo houstonensis</i>	Amphibian
Red Hills salamander	<i>Phaeognathus hubrichti</i>	Amphibian
San Marcos salamander	<i>Eurycea nana</i>	Amphibian
Barton Springs salamander	<i>Eurycea sosorum</i>	Amphibian
Frosted Flatwoods salamander	<i>Ambystoma cingulatum</i>	Amphibian
Jollyville Plateau salamander	<i>Eurycea tonkawae</i>	Amphibian
Georgetown salamander	<i>Eurycea naufragia</i>	Amphibian
Salado salamander	<i>Eurycea chisholmensis</i>	Amphibian
Austin blind salamander	<i>Eurycea waterlooensis</i>	Amphibian
Reticulated flatwoods salamander	<i>Ambystoma bishopi</i>	Amphibian
Big Bend gambusia	<i>Gambusia gaigei</i>	Fish
Clear Creek gambusia	<i>Gambusia heterochir</i>	Fish
Comanche Springs pupfish	<i>Cyprinodon elegans</i>	Fish
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Fish
Fountain darter	<i>Etheostoma fonticola</i>	Fish
Watercress darter	<i>Etheostoma nuchale</i>	Fish
Pecos gambusia	<i>Gambusia nobilis</i>	Fish
Alabama cavefish	<i>Speoplatyrhinus poulsoni</i>	Fish
Pygmy Sculpin	<i>Cottus paulus (=pygmaeus)</i>	Fish
Cape Fear shiner	<i>Notropis mekistocholas</i>	Fish
Waccamaw silverside	<i>Menidia extensa</i>	Fish
San Marcos gambusia	<i>Gambusia georgei</i>	Fish
Leon Springs pupfish	<i>Cyprinodon bovinus</i>	Fish
Alabama sturgeon	<i>Scaphirhynchus suttkusi</i>	Fish
Cherokee darter	<i>Etheostoma scotti</i>	Fish
Devils River minnow	<i>Dionda diaboli</i>	Fish
Cahaba shiner	<i>Notropis cahabae</i>	Fish
Palezone shiner	<i>Notropis albizonatus</i>	Fish
Sharpnose Shiner	<i>Notropis oxyrhynchus</i>	Fish
Sunfish, spring pygmy	<i>Elassoma alabamae</i>	Fish
Goldline darter	<i>Percina aurolineata</i>	Fish
Relict darter	<i>Etheostoma chienense</i>	Fish
Etowah darter	<i>Etheostoma etowahae</i>	Fish
Vermilion darter	<i>Etheostoma chermocki</i>	Fish
Smalltooth sawfish	<i>Pristis pectinata</i>	Fish
Rush Darter	<i>Etheostoma phytophilum</i>	Fish
Yellow blossom (pearlymussel)	<i>Epioblasma florentina florentina</i>	Bivalve
Ring pink (mussel)	<i>Obovaria retusa</i>	Bivalve
Flat pigtoe	<i>Pleurobema marshalli</i>	Bivalve

Heavy pigtoe	<i>Pleurobema taitianum</i>	Bivalve
Tar River spinymussel	<i>Elliptio steinstansana</i>	Bivalve
Choctaw bean	<i>Villosa choctawensis</i>	Bivalve
Cumberland elktoe	<i>Alasmodonta atropurpurea</i>	Bivalve
Alabama pearlshell	<i>Margaritifera marrianae</i>	Bivalve
Cracking pearlymussel	<i>Hemistena lata</i>	Bivalve
James spinymussel	<i>Pleurobema collina</i>	Bivalve
Altamaha Spinymussel	<i>Elliptio spinosa</i>	Bivalve
Dwarf wedgemussel	<i>Alasmodonta heterodon</i>	Bivalve
Southern acornshell	<i>Epioblasma othcaloogensis</i>	Bivalve
Purple bankclimber (mussel)	<i>Elliptoideus sloatianus</i>	Bivalve
Upland combshell	<i>Epioblasma metastrata</i>	Bivalve
Round Ebonyshell	<i>Fusconaia rotulata</i>	Bivalve
Carolina heelsplitter	<i>Lasmigona decorata</i>	Bivalve
Southern kidneyshell	<i>Ptychobranhus jonesi</i>	Bivalve
Oval pigtoe	<i>Pleurobema pyriforme</i>	Bivalve
Narrow pigtoe	<i>Fusconaia escambia</i>	Bivalve
Shinyrayed pocketbook	<i>Lampsilis subangulata</i>	Bivalve
Southern sandshell	<i>Hamiota (=Lampsilis) australis</i>	Bivalve
Fat three-ridge (mussel)	<i>Amblema neislerii</i>	Bivalve
Dark pigtoe	<i>Pleurobema furvum</i>	Bivalve
Gulf moccasinshell	<i>Medionidus penicillatus</i>	Bivalve
Ochlockonee moccasinshell	<i>Medionidus simpsonianus</i>	Bivalve
Chipola slabshell	<i>Elliptio chipolaensis</i>	Bivalve
Fuzzy pigtoe	<i>Pleurobema strodeanum</i>	Bivalve
Tapered pigtoe	<i>Fusconaia burkei</i>	Bivalve
Noonday globe	<i>Patera clarki nantahala</i>	Gastropod
Phantom springsnail	<i>Pyrgulopsis texana</i>	Gastropod
Phantom tryonia	<i>Tryonia cheatumi</i>	Gastropod
Armored snail	<i>Pyrgulopsis (=Marstonia) pachyta</i>	Gastropod
Pecos assiminea snail	<i>Assiminea pecos</i>	Gastropod
Diamond Y Spring snail	<i>Pseudotryonia adamantina</i>	Gastropod
Tulotoma snail	<i>Tulotoma magnifica</i>	Gastropod
Gonzales springsnail	<i>Tryonia circumstriata</i>	Gastropod
Lacy elimia (snail)	<i>Elimia crenatella</i>	Gastropod
Rough hornsnail	<i>Pleurocera foremani</i>	Gastropod
Cylindrical lioplax (snail)	<i>Lioplax cyclostomaformis</i>	Gastropod
Flat pebblesnail	<i>Lepyrium showalteri</i>	Gastropod
Painted rocksnail	<i>Leptoxis taeniata</i>	Gastropod
Plicate rocksnail	<i>Leptoxis plicata</i>	Gastropod
Round rocksnail	<i>Leptoxis ampla</i>	Gastropod
Slender campeloma	<i>Campeloma decampi</i>	Gastropod
Interrupted (=Georgia) Rocksnail	<i>Leptoxis foremani</i>	Gastropod
Hungerford's crawling water Beetle	<i>Brychius hungerfordi</i>	Insect
Coffin Cave mold beetle	<i>Batrisodes texanus</i>	Insect

Kretschmarr Cave mold beetle	<i>Texamaurops reddelli</i>	Insect
Tooth Cave ground beetle	<i>Rhadine persephone</i>	Insect
Comal Springs riffle beetle	<i>Heterelmis comalensis</i>	Insect
Comal Springs dryopid beetle	<i>Stygoparnus comalensis</i>	Insect
Saint Francis' satyr butterfly	<i>Neonympha mitchellii francisci</i>	Insect
[Unnamed] ground beetle	<i>Rhadine infernalis</i>	Insect
Helotes mold beetle	<i>Batrisodes venyivi</i>	Insect
[Unnamed] ground beetle	<i>Rhadine exilis</i>	Insect
Bee Creek Cave harvestman	<i>Texella reddelli</i>	Arachnid
Bone Cave harvestman	<i>Texella reyesi</i>	Arachnid
Tooth Cave pseudoscorpion	<i>Tartarocreagris texana</i>	Arachnid
Tooth Cave Spider	<i>Leptoneta myopica</i>	Arachnid
Cokendolpher Cave Harvestman	<i>Texella cokendolpheri</i>	Arachnid
Government Canyon Bat Cave Spider	<i>Neoleptoneta microps</i>	Arachnid
Madla's Cave Meshweaver	<i>Cicurina madla</i>	Arachnid
Robber Baron Cave Meshweaver	<i>Cicurina baronia</i>	Arachnid
Government Canyon Bat Cave Meshweaver	<i>Cicurina vespera</i>	Arachnid
Braken Bat Cave Meshweaver	<i>Cicurina venii</i>	Arachnid
Peck's cave amphipod	<i>Stygobromus (=Stygonectes) pecki</i>	Crustacean
Alabama cave shrimp	<i>Palaemonias alabamiae</i>	Crustacean
Kentucky cave shrimp	<i>Palaemonias ganteri</i>	Crustacean
Diminutive Amphipod	<i>Gammarus hyalleloides</i>	Crustacean
Star cactus	<i>Astrophytum asterias</i>	Dicot
Pecos (=puzzle, =paradox) sunflower	<i>Helianthus paradoxus</i>	Dicot
Neches River rose-mallow	<i>Hibiscus dasycalyx</i>	Dicot
Kentucky glade cress	<i>Leavenworthia exigua laciniata</i>	Dicot
Fleshy-Fruit Gladecress	<i>Leavenworthia crassa</i>	Dicot
Zapata bladderpod	<i>Lesquerella thamnophila</i>	Dicot
Ashy dogweed	<i>Thymophylla tephroleuca</i>	Dicot
South Texas ambrosia	<i>Ambrosia cheiranthifolia</i>	Dicot
Little amphianthus	<i>Amphianthus pusillus</i>	Dicot
Tobusch fishhook cactus	<i>Sclerocactus brevihamatus ssp. tobuschii</i>	Dicot
Hairy rattleweed	<i>Baptisia arachnifera</i>	Dicot
Texas poppy-mallow	<i>Callirhoe scabriuscula</i>	Dicot
Small-anthered bittercress	<i>Cardamine micranthera</i>	Dicot
Nellie cory cactus	<i>Coryphantha minima</i>	Dicot
Bunched cory cactus	<i>Coryphantha ramillosa</i>	Dicot
Sneed pincushion cactus	<i>Coryphantha sneedii</i> var. <i>sneedii</i>	Dicot
Black lace cactus	<i>Echinocereus reichenbachii</i> var. <i>albertii</i>	Dicot
Davis' green pitaya	<i>Echinocereus viridiflorus</i> var. <i>davisii</i>	Dicot
Lloyd's Mariposa cactus	<i>Echinomastus mariposensis</i>	Dicot
Johnston's frankenia	<i>Frankenia johnstonii</i>	Dicot
Dwarf-flowered heartleaf	<i>Hexastylis naniflora</i>	Dicot
Slender rush-pea	<i>Hoffmannseggia tenella</i>	Dicot
Lyrate bladderpod	<i>Lesquerella lyrata</i>	Dicot

Walker's manioc	<i>Manihot walkerae</i>	Dicot
Mohr's Barbara button	<i>Marshallia mohrii</i>	Dicot
Texas trailing phlox	<i>Phlox nivalis ssp. texensis</i>	Dicot
Little Aguja (=Creek) Pondweed	<i>Potamogeton clystocarpus</i>	Monocot
Hinckley oak	<i>Quercus hinckleyi</i>	Dicot
Miccosukee gooseberry	<i>Ribes echinellum</i>	Dicot
Bunched arrowhead	<i>Sagittaria fasciculata</i>	Monocot
Green pitcher-plant	<i>Sarracenia oreophila</i>	Dicot
Fringed campion	<i>Silene polypetala</i>	Dicot
White-haired goldenrod	<i>Solidago albopilosa</i>	Dicot
Gentian pinkroot	<i>Spigelia gentianoides</i>	Dicot
Navasota ladies'-tresses	<i>Spiranthes parksii</i>	Monocot
Texas snowbells	<i>Styrax texanus</i>	Dicot
Cooley's meadowrue	<i>Thalictrum cooleyi</i>	Dicot
Persistent trillium	<i>Trillium persistens</i>	Monocot
Texas wild-rice	<i>Zizania texana</i>	Monocot
Large-fruited sand-verbena	<i>Abronia macrocarpa</i>	Dicot
Sensitive joint-vetch	<i>Aeschynomene virginica</i>	Dicot
Terlingua Creek cat's-eye	<i>Cryptantha crassipes</i>	Dicot
Smooth coneflower	<i>Echinacea laevigata</i>	Dicot
Chisos Mountain hedgehog Cactus	<i>Echinocereus chisoensis var. chisoensis</i>	Dicot
Schweinitz's sunflower	<i>Helianthus schweinitzii</i>	Dicot
Swamp pink	<i>Helonias bullata</i>	Monocot
Heller's blazingstar	<i>Liatris helleri</i>	Dicot
Rough-leaved loosestrife	<i>Lysimachia asperulaefolia</i>	Dicot
Michigan monkey-flower	<i>Mimulus michiganensis</i>	Dicot
Canby's dropwort	<i>Oxypolis canbyi</i>	Dicot
Michaux's sumac	<i>Rhus michauxii</i>	Dicot
Alabama canebrake pitcher-plant	<i>Sarracenia rubra alabamensis</i>	Dicot
Mountain sweet pitcher-plant	<i>Sarracenia rubra ssp. jonesii</i>	Dicot
Houghton's goldenrod	<i>Solidago houghtonii</i>	Dicot
Seabeach amaranth	<i>Amaranthus pumilus</i>	Dicot
White bladderpod	<i>Lesquerella pallida</i>	Dicot
Relict trillium	<i>Trillium reliquum</i>	Monocot
Texas prairie dawn-flower	<i>Hymenoxys texana</i>	Dicot
Alabama leather flower	<i>Clematis socialis</i>	Dicot
Mountain golden heather	<i>Hudsonia montana</i>	Dicot
Kral's water-plantain	<i>Sagittaria secundifolia</i>	Monocot
Texas ayenia	<i>Ayenia limitaris</i>	Dicot
Texas Golden Gladecress	<i>Leavenworthia texana</i>	Dicot
White irisette	<i>Sisyrinchium dichotomum</i>	Monocot
Golden sedge	<i>Carex lutea</i>	Monocot
Florida torreyia	<i>Torreya taxifolia</i>	Conf/cycds
Black spored quillwort	<i>Isoetes melanospora</i>	Ferns
Mat-forming quillwort	<i>Isoetes tegetiformans</i>	Ferns

Alabama streak-sorus fern	<i>Thelypteris pilosa</i> var. <i>alabamensis</i>	Ferns
False killer whale	<i>Pseudorca crassidens</i>	Mammal

Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Field –Accounting for Spray Drift Mitigation Labeling Restrictions.

The spray drift (in-field buffer) and rainfast mitigations discussed in the cotton section 3 ecological risk assessment (D404823), the concurrently issued soybean addendum (D426789) and at the beginning of this assessment are anticipated to restrict dicamba and DCSA residues above any threshold toxicity values to the agricultural field. Therefore, the following table describes the habitat and rationale for all listed species that were determined to not use cotton and soybean fields or resources that may overlap with dicamba DGA uses.

Species	Habitat	Rationale	Source
Animals			
<u>Alabama beach mouse</u> (<i>Peromyscus polionotus ammobates</i>)	Coastal sand dunes and coastal scrub (USFWS 1987, p. 2), (USFWS 2007, p. 4330); primary, secondary and interior or scrub dunes (USFWS 2009, p. 4, 11)	The proposed dicamba DGA uses are not expected to overlap with sand dunes of coastal scrub.	<p>USFWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/870812.pdf</p> <p>Federal Register. 2007. Department of the Interior, Fish and Wildlife Service. 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Alabama Beach Mouse. Vol. 72, No. 19. January 30, 2007. Available online at: http://www.gpo.gov/fdsys/pkg/FR-2007-01-30/pdf/07-270.pdf#page=1</p> <p>USFWS. 2009. Alabama beach mouse (<i>Peromyscus polionotus ammobates</i>, Bowen 1968), 5-Year Review: Summary and Evaluation. Daphne, Alabama. 34 pp. Available online at: http://ecos.fws.gov/docs/five_year_review/doc2996.pdf.</p>

Species	Habitat	Rationale	Source
Alabama Red-belly turtle (<i>Pseudemys alabamensis</i>)	Streams, lakes and sloughs (USFWS, 1990, p. 1)	The proposed dicamba DGA uses are not expected to overlap with streams, lakes or sloughs.	USFWS. 1990. Recovery Plan for the Alabama Red-bellied Turtle. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/900108.pdf
<u>Austin blind salamander</u> (<i>Eurycea waterlooensis</i>)	Strictly aquatic and spend their entire lives submersed in water from the Barton Springs Segment of the Edwards Aquifer (Hillis et al. 2001, p. 273)(Page 51340) Rocky substrate, consisting of boulder, cobble, and gravel, with interstitial spaces that have minimal sediment (Page 51341)	The proposed dicamba DGA uses are not expected to overlap with water bodies.	USFWS 2013. <u>Designation of Critical Habitat for the Austin Blind and Jollyville Plateau Salamanders; Final Rule</u>
<u>Bachman's warbler</u> (<i>Vermivora bachmanii</i>)	Breeds in palustrine forested wetlands; seen near longleaf pine forest near brackish marsh. (USFWS 2007)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2007. Five Year Review: http://ecos.fws.gov/docs/five_year_review/doc1037.pdf
<u>Barton Springs salamander</u> (<i>Eurycea sosorum</i>)	Aquatic. Stenothermal spring flows, substrates are mixtures of gravel, cobble, aquatic plants, leaf litter and are free of sediment. Pools and spring runs, subsurface portions of the aquifer (within water-bearing karst formations). Found under boulder, cobble, gravel and plant (aquatic plants, leaf litter, woody debris) substrates. (USFWS 2005)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2005. Barton Springs salamander (<i>Eurycea sosorum</i>) recovery plan. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/050921.pdf .

Species	Habitat	Rationale	Source
<u>Bean</u> <u>Cumberland</u> <u>(pearlymussel)</u> <u>(<i>Villosa</i></u> <u><i>trabalis</i>)</u>	Restricted typically to tributary streams of the upper reaches of the Tennessee and Cumberland Rivers. This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, <i>V. trabalis</i> is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species (US FWS 2010, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc3244.pdf
Rayed Bean (<i>Villosa fabalis</i>)	Generally known from smaller, headwater creeks, but occurrence records exist from larger rivers. Usually found in or near shoal or riffle areas and in the shallow, wave-washed areas of glacial lakes.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Rayed Bean and Snuffbox Mussels Throughout Their Ranges. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
<u>Black-capped</u> <u>vireo (<i>Vireo</i></u> <u><i>atricapilla</i>)</u>	Insect-eating, migratory songbird. Arrive in Texas from mid-March to mid-April, while those in Oklahoma arrive approximately 10 days later. Breeding habitat is quite variable across its range, but is generally shrublands with a distinctive patchy structure. The shrub vegetation is mostly deciduous and generally extends from the ground to about six feet above ground and covers	The proposed dicamba DGA uses are not expected to overlap with shrublands associated with rocky gullies, edges of ravines, or eroded slopes.	USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1073.pdf USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910930h.pdf

Species	Habitat	Rationale	Source
	about 30 to 60% of the total area. Open grassland separates the clumps of shrubs. (US FWS 2007, p. 7) From Oklahoma through most of Texas, this type of vegetational configuration occurs most frequently on rocky substrates with shallow soils, in rocky gullies, on edges of ravines, and on eroded slopes. (US FWS 1991, p. 20)		
Butterfly, Kamer blue (<i>Lycaeides melissa samuelis</i>)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy (US FWS, 2003, pp.28-30)	The proposed dicamba DGA uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf
Butterfly, Mitchell's satyr (<i>Neonympha mitchellii mitchellii</i>)	Mitchell's satyr habitat is best characterized as a sedge-dominated fen community; Known habitats are all peatlands but range along a continuum from prairie/bog fen to sedge meadow/swamp. However, certain attributes at each site remain fairly constant. All historical and active habitats have a herbaceous community which is dominated by sedges, usually <i>Carex stricta</i> , with scattered deciduous and/or coniferous trees, most often <i>L. laricina</i> or <i>Juniperus virginiana</i> (red cedar) (US FWS 1998, pp. 11-12).	The proposed dicamba DGA uses are not expected to overlap with wetlands or areas with sedge communities.	USFWS 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf
Chub, spotfin (<i>Erimonax monachus</i>)	The species is an insectivore, feeding diurnally presumably by both sight and taste in benthic areas of slow to swift current over various substrates with little siltation.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/831121.pdf

Species	Habitat	Rationale	Source
	Streams may range from 15-60 m in width and, where occupied, 0.3-10.0 m in depth. Water temperature in their summer habitat usually reaches greater than 20°C, and submerged macrophytes are usually absent, occasionally common. The species has been observed associated with sand, gravel, rubble, boulder, and bedrock substrates (Jenkins and Burkhead, 1982) (US FWS 1983, p. 15).		
<u>Clubshell</u> (<i>Pleurobema clava</i>)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf
<u>Clubshell, ovate</u> (<i>Pleurobema perovatum</i>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 56)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Clubshell, southern</u> (<i>Pleurobema decisum</i>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 58)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Combshell, Cumberlandian</u> (<i>Epioblasma brevidens</i>)	This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse, sand, gravel, cobble, and boulders. It is not associated with small stream habitats and tends not to extend as far upstream in tributaries (US FWS 2004, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
<u>Combshell</u> <u>southern</u> <u>(Epioblasma</u> <u>penita)</u>	This species inhabits the Tombigbee River, which is a major western tributary of the Mobile Basin. It is characterized by an increasing number of sand and gravel shoals and decreasing channel size (US FWS, 1989, p. 1)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Dace, blackside</u> <u>(Phoxinus</u> <u>cumberlandensi</u> <u>s)</u>	This species inhabits cool, small, upland streams with moderate flows. The fish is generally associated with undercut stream banks and large rocks, and it is usually found within well-vegetated watersheds with good riparian vegetation (US FWS 1988, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/880817.pdf
<u>Darter, amber</u> <u>(Percina</u> <u>antesella)</u>	This species inhabits gentle riffle areas over sand, gravel, and cobble substrates. Aquatic vegetation that develops in riffles provides habitat for feeding and cover (US FWS, 1986, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf
<u>Darter, boulder</u> <u>(Etheostoma</u> <u>wapiti)</u>	This species inhabits warm-water riverine environments and has been found only in moderate to fast current over boulder/slab rock substrate in water over 2 feet deep (US FWS, 1989, p. 2).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890727.pdf
<u>Darter,</u> <u>Cumberland</u> <u>(Etheostoma</u> <u>susanae)</u>	This species inhabits pools or shallow runs of low to moderate gradient sections of streams with stable sand, silt, or sand-covered bedrock substrates (US FWS, 2012, p. 63605).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designated Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>Darter,</u> <u>duskytail</u> <u>(Etheostoma</u> <u>percnurum)</u>	This species inhabits rocky areas in gently flowing shallow pools and runs in large creeks and moderately large rivers in the Tennessee and Cumberland River Systems (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/duskytaildarter_RP.pdf

Species	Habitat	Rationale	Source
<u>Darter, slackwater</u> (<i>Etheostoma boschungii</i>)	Nonbreeding habitat is small to moderately large streams. The current is usually slow, and under normal conditions, the flow ranges from still to 0.34 m/sec. In small streams, the darters show no position preference; however, in large streams they seem to confine themselves to near the banks or to undercuts in the banks. They also occur on gravel infiltrated with silt, on silt and mud, or in a combination of these. The breeding habitat is seepage water in open fields and woods (US FWS, 1984, pp. 7-8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840308.pdf
<u>Darter, snail</u> (<i>Percina tanasi</i>)	This species occupies seven of nine tributaries of the upper Tennessee River in Alabama, Georgia and Tennessee (US FWS, 2013, p. 10).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4136.pdf
<u>Dragonfly, Hine's emerald</u> (<i>Somatochlora hineana</i>)	The Hine's emerald dragonfly occupies grass marshes and sedge meadows fed primarily by water from a mineral source or fens. Two important characteristics of the habitat appear to be groundwater-fed, shallow water slowly flowing through vegetation, and underlying dolomitic or limestone bedrock. Parts of the aquatic channels are typically covered by vegetation such as cattails or sedges. Soils can range from organic muck to mineral soils like marl. Two other important components are areas of open vegetation for foraging and forests, trees or shrubs that provide shaded areas for perching or roosting. Nearby adjacent	The proposed dicamba DGA uses are not expected to overlap with grass marshes, sedge meadows, forested areas, or other habitat where the Hine's emerald dragonfly is expected to be found.	USFWS. 2001. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/010927.pdf

Species	Habitat	Rationale	Source
	<p>forests may be deciduous (Illinois) or conifer (Wisconsin and Michigan).</p> <p>Larvae are usually found in small flowing streamlets within cattail marshes, sedge meadows, and hummocks. Places with silt, leaf litter, and decaying grasses as a substrate are often used (US FWS, 2001, p. 15-16.).</p> <p>Critical Habitat of 26,531 acres have been designated in Michigan, Illinois, Wisconsin, and Missouri. Almost half of this is Mackinac County, MI.</p>		
<u>Elktoe, Appalachian</u> <u>(<i>Alasmidonta</i></u> <u><i>raveneliana</i>)</u>	This species has been reported from relatively shallow medium-sized creeks and rivers with cool, well-oxygenated, and moderate-to fast-flowing water. It has been observed in gravelly substrata, often mixed with cobble and boulders; in cracks in bedrock; and occasionally in relatively silt-free, coarse, sandy substrata (US FWS, 1996, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960826.pdf
<u>False killer whale</u> <u>(<i>Pseudorca</i></u> <u><i>crassidens</i>)</u>	Deep water: "They prefer tropical to temperate waters that are deeper than 3,300 feet (1000 m)."	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/falsekillerwhale.htm
<u>Fanshell</u> <u>(<i>Cyprogenia</i></u> <u><i>stegaria</i>)</u>	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf

Species	Habitat	Rationale	Source
<u>Flattened musk turtle</u> (<i>Sternotherus depressus</i>)	Streams, Lake margins (USFWS 1990, p 3); spend most of their time in benthic habitats (USFWS 1990, p 5) Optimum habitat includes creeks and small rivers with vegetated areas with depth of 3 - 600 cm (USFWS 1990, p 3)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks or other water bodies.	USFWS. 1990. Recovery Plan for the Flattened Musk Turtle. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/900226.pdf
<u>Frosted Flatwoods salamander</u> (<i>Ambystoma cingulatum</i>)	Fire-maintained, open-canopied, flatwoods and savannas dominated by longleaf pine (<i>Pinus palustris</i>), with naturally occurring slash pine (<i>P. elliotti</i>) in wetter areas. Adults spend most of their lives underground. Breed in small, isolated ephemeral ponds (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with flatwoods or savannas.	USFWS 2009. Federal Register, vol. 74, No. 62. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
<u>Georgetown salamander</u> (<i>Eurycea nanafragia</i>)	Aquatic. The Northern Segment of the Edwards Aquifer, which is a karst aquifer characterized by open chambers such as caves, fractures, and other cavities that were formed either directly or indirectly by dissolution of subsurface rock formations. (USFWS 2014, Pg. 10237)	The proposed dicamba DGA uses are not expected to overlap with cave aquifers.	USFWS 2014. <u>Determination of Threatened Species Status for the Georgetown Salamander and Salado Salamander Throughout Their Ranges. Final Rule</u>
<u>Golden-cheeked warbler</u> (<i>Dendroica chrysoparia</i>)	Forest (USFWS 1992, p. 7)	The proposed dicamba DGA uses are not expected to overlap with forest.	USFWS 1992. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/920930f.pdf
<u>Heelsplitter, Alabama (=inflated)</u> (<i>Potamilus inflatus</i>)	This species prefers a soft, stable substrate in slow to moderate currents. It has been found in sand, mud, silt and sandy-gravel, but not in large or armored gravel (US FWS, 1993, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930413.pdf

Species	Habitat	Rationale	Source
<u>Jollyville Plateau salamander</u> (<i>Eurycea tonkawae</i>)	Jollyville Plateau salamanders are strictly aquatic and spend their entire lives submersed in water sourced from the Northern Segment of the Edwards Aquifer, the Trinity Aquifer, and local alluvium (loose unconsolidated soils) (COA 2001, pp. 3–4; Bowles et al. 2006, p. 112; Johns 2011, p. 5–6). (Page 51340) Rocky substrate, consisting of boulder, cobble, and gravel, with interstitial spaces that have minimal sediment (Page 51341)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks or other water bodies.	USFWS 2013. <u>Designation of Critical Habitat for the Austin Blind and Jollyville Plateau Salamanders: Final Rule</u>
<u>Kidneyshell, fluted</u> (<i>Ptychobranchius subtentum</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
<u>Kidneyshell, triangular</u> (<i>Ptychobranchius greenii</i>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 60)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf
<u>Lampmussel, Alabama</u> (<i>Lampsilis virescens</i>)	This species inhabits sand and gravel substrates in small to medium sized streams (US FWS, 1985, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf

Species	Habitat	Rationale	Source
<u>Lilliput, pale (pearly mussel) (<i>Toxolasma cylindrellus</i>)</u>	This species is observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840822.pdf
<u>Loggerhead sea turtle (<i>Caretta caretta</i>)</u>	Ocean, Beaches, Neritic zone (NMFS 2009, p I-20)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS and USFWS. 2009. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle, Second Revision. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/090116.pdf
<u>Logperch, Conasauga (<i>Percina jenikins</i>)</u>	This species has been collected in deep shuts and flowing pools with clear, clean gravel and mixed rubble substrates in areas with moderate to swift currents (US FWS, 1986, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf
<u>Lynx, Canada (<i>Lynx canadensis</i>)</u>	PCE: Boreal forest landscapes with large populations of snowshoe hares. Distribution and abundance of prey and microclimate influence movement, hunting behavior, and den and resting site locations. Areas with dense cover.	The proposed dicamba DGA uses are not expected to overlap with boreal forests. The lynx's prey, snowshoe hares, also do not overlap with the proposed dicamba DGA use sites.	USFWS. 2014. Federal Register Notice: Designation of Critical Habitat http://www.gpo.gov/fdsys/pkg/FR-2014-09-12/pdf/2014-21013.pdf
<u>Manatee, West Indian (<i>Trichechus manatus</i>)</u>	This species lives in freshwater, brackish and marine habitats (US FWS, 2001, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2001. Recovery Plan- Third Revision. http://ecos.fws.gov/docs/recovery_plan/011030.pdf

Species	Habitat	Rationale	Source
Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)	The Mexican long-nosed bat has evolved an apparent mutualistic association with <i>Agave sp.</i> The bat is principally a nectar feeder, foraging on the flowers of <i>Agave</i> , and in some minor proportions consuming the pollen, fruits, and any incidental insects associated with the flowers. The bats occupy mid- to high-elevational desert scrub, open conifer-oak woodlands, and pine forest habitats in the Upper Sonoran and Transition Life Zones.	The proposed dicamba DGA uses are not expected to overlap with the desert scrub, open conifer-oak woodlands and pine forest habitats of the bat. The bat's major resource need, <i>Agave</i> plants are not expected to be on soybean and cotton fields.	USFWS. 1994. Recovery Plan. https://ecos.fws.gov/docs/recovery_plan/940908.pdf
Mexican spotted owl (<i>Strix occidentalis lucida</i>)	Forest and canyonlands in SW U.S. (USFWS 2011, p. 7).	The proposed dicamba DGA uses are not expected to overlap with forests or Canyonlands.	USFWS 2011. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/FR00000557-%20BP031995%20Draft%20MSO%20Recovery%20Plan%20First%20Revision.pdf
Moccasinshell, Alabama (<i>Medionidus acutissimus</i>)	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 51)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
Moccasinshell, Coosa (<i>Medionidus parvulus</i>)	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 52)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
Monkeyface, Cumberland (pearly mussel) (<i>Quadrula intermedia</i>)	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709b.pdf

Species	Habitat	Rationale	Source
	and shoal areas (US FWS, 1984, p. 9).		
<u>Mucket, orangenacre</u> <u>(<i>Lampsilis perovalis</i>)</u>	Currently restricted to high quality stream and small river habitat, the species is found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS 2000, p. 55)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Mucket, pink (pearly mussel)</u> <u>(<i>Lampsilis abrupta</i>)</u>	<p>The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10).</p> <p>The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the water is flowing (US FWS, 1985, p. 10).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf
<u>Mussel, oyster</u> <u>(<i>Epioblasma capsaeformis</i>)</u>	This species is generally adapted to live in the gravel shoals of free-flowing rivers and streams (US FWS, 2004, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
<u>Mussel, sheepnose</u> <u>(<i>Plethobasus cyphus</i>)</u>	The sheepnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf

Species	Habitat	Rationale	Source
	boulders. Sheepnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).		
<u>Mussel, snuffbox (<i>Epioblasma triquetra</i>)</u>	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Federal Register Notice: Listing. http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27413.pdf#page=2 USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
<u>North Atlantic Right Whale (<i>Eubalaena glacialis</i>)</u>	The North Atlantic right whale primarily occurs in coastal or shelf waters, but may go into deeper waters. (NMFS 2004, p. v)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS. 2004. Recovery plan for the north Atlantic right whale (<i>Eubalaena glacialis</i>). Available online at: http://ecos.fws.gov/docs/recovery_plan/whale_right_northatlantic.pdf
<u>Northern aplomado falcon (<i>Falco femoralis septentrionalis</i>)</u>	Open terrain with scattered trees or shrubs. Found along yacca covered sand ridges in coastal prairies Riparian woodlands in open grasslands Desert grasslands (USFWS 1990, p. 13).	Recommend off-field status for row crop agriculture. According to the Aplomado Recovery Plan (USFWS 1990), suitable habitat contains of terrain with inter-tree distances of 15 to 45 m with a mean of 30 m and a woody plant density of 0.48 tree/ha. The suitable land covers include yucca-covered ridges of coastal prairies,	USFWS 1990. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/900608.pdf

Species	Habitat	Rationale	Source
		grasslands, prairies, desert grasslands, and riparian wooded areas near open grasslands. While the recovery plan is not specific as to row crop usage by the species, additional information on monitored individual falcons in Texas indicated that the only agricultural association with foraging falcons is for grazing lands and for fallow agricultural fields. (Perez et al. 1996)	
<u>Pearlymussel, dromedary</u> (<i>Dromus dromas</i>)	This species is most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
<u>Pearlymussel, littlewing</u> (<i>Pegias fabula</i>)	This species inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins (US FWS, 1989, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890922.pdf
<u>Pearlymussel, Slabside</u> (<i>Pleuromma dolabelloides</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf

Species	Habitat	Rationale	Source
	finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)		
<u>Perdido Key beach mouse</u> (<i>Peromyscus polionotus trissyllepsis</i>)	Coastal sand dunes & coastal scrub (USFWS 1987, p. 2); primary, secondary and interior or scrub dunes (USFWS 2007, p. 9)	The proposed dicamba DGA uses are not expected to overlap with sand dunes or coastal scrub.	USFWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/870812.pdf . USFWS. 2007. Perdido Key Beach Mouse (<i>Peromyscus polionotus trissyllepsis</i>), 5-Year Review: Summary and Evaluation. Panama City, Florida. 24 pp. Available online at: http://ecos.fws.gov/docs/five_year_review/doc1081.pdf .
<u>Pigtoe, finerayed</u> (<i>Fuscona cuneolus</i>)	This species is typically a riffle species that inhabits ford and shoal areas in free-flowing streams of moderate gradient (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/fine%20rayed%20recov%20plan.pdf
<u>Pigtoe, Georgia</u> (<i>Pleurobema hanleyianum</i>)	This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. It also requires a host fish, which is currently unknown (US FWS, 2013, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Draft Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Hartfield%20and%20Powell%202013%20Draft%20Three%20Mollusks%20RP%20062813.pdf
<u>Pigtoe, rough</u> (<i>Pleurobema plenum</i>)	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and in sand and gravel substrates (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf

Species	Habitat	Rationale	Source
<u>Pigtoe, shiny</u> <u>Entire</u> <u>(Fusconaia cor)</u>	This species is typically a riffle species, found along fords and shoals of clear, moderate to fast-flowing streams and rivers with stable substrate. It does not inhabit deep pools or impounded areas. This species is usually found well-buried in the substrate during most of the year and is more readily visible in early summer (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709d.pdf
<u>Pigtoe, southern</u> <u>(Pleurobema</u> <u>georgianum)</u>	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 59)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Pimpleback,</u> <u>orangefoot</u> <u>(pearlymussel)</u> <u>(Plethobasus</u> <u>cooperianus)</u>	The 1984 Recovery Plan indicated that the orange-foot pimpleback was known from the Tennessee, Cumberland, and lower Ohio Rivers (US FWS, 1984, p. 2). The habitat is described as medium to large rivers in sand and gravel substrates. In the Ohio River it was collected from 15-29 feet depths, but may have lived in shallower riffles (US FWS, 1984, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840930b.pdf
<u>Plover, piping</u> <u>except Great</u> <u>Lakes</u> <u>watershed</u> <u>(Charadrius</u> <u>melodus)</u>	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation. At inland lakes, they use barren	The proposed dicamba DGA uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf

Species	Habitat	Rationale	Source
	to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).		
<u>Pocketbook, fat</u> <u>(Potamilus</u> <u>capax)</u>	The fat pocketbook is a large river species requiring flowing water and a stable substrate, which can vary widely but is most likely a mixture of sand, silt and clay. It occurs in water from a few inches deep to at least 8 feet. Habitat includes drainage ditches. (US FWS, 1989, p. 6). Populations have been found in larger rivers in the Ohio River system, and it may occur as deep as 20 feet (US FWS, 2012, p. 7-8). It can also tolerate periods of high suspended sediments (US FWS, 2012, p. 11).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf
<u>Pocketbook,</u> <u>finelined</u> <u>(Lampsilis</u> <u>atilis)</u>	Live embedded in the bottom sand, gravel, and/or cobble substrates of rivers and streams (US FWS 2004, p. 40097).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks or other water bodies.	USFWS. 2004. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2004-07-01/pdf/04-14279.pdf#page=1
<u>Purple Cat's</u> <u>paw (=Purple</u> <u>Cat's paw</u> <u>pearlymussel)</u> <u>(Epioblasma</u> <u>obliquata</u> <u>obliquata)</u>	Inhabits boulder to sandy substrates in large rivers of the Ohio River basin (US FWS 1992, Executive summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920310.pdf
<u>Rabbitsfoot</u> <u>(Quadrula</u> <u>cylindrica</u> <u>cylindrica)</u>	"Rabbits foot is primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity." They have been reported in deep water runs up to 12 feet depth.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf

Species	Habitat	Rationale	Source
	"Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).		
<u>Red Hills salamander</u> (<i>Phaeognathus hubrichti</i>)	Mesic ravine slopes and bluff sides (facing North) with hardwood trees. Burrows within siltstone. Usually found on sites with loamy, friable topsoils (USFWS 1983)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery plan for the red hills salamander (<i>Phaeognathus hubrichti</i> Highton). United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/831123.pdf
<u>Reticulated flatwoods salamander</u> (<i>Ambystoma bishopi</i>)	Aquatic and terrestrial. Longleaf pine ecosystems (Coastal Plain in what were historically longleaf pine-wiregrass flatwoods and savannas). Adults spend most of their lives underground. Breed in small, isolated ephemeral ponds. (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2009. Federal Register, vol. 74, No. 26. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
<u>Riffleshell, northern</u> (<i>Epioblasma torulosa rangiana</i>)	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf

Species	Habitat	Rationale	Source
<u>Riversnail, Anthony's</u> <u>(<i>Athearnia anthonyi</i>)</u>	This species is typically found in large streams on large submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water (US FWS, 1997).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970813.pdf
<u>Roseate tern</u> <u>(<i>Sterna dougallii dougallii</i>)</u>	Rocky offshore islands with sparse vegetation; although Northeastern Roseate tern nest under vegetation or some other shelter (USFWS 1993, p. 3).	The proposed dicamba DGA uses are not expected to overlap with offshore islands.	USFWS 1993. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/930924_v2.pdf
<u>Salado salamander</u> <u>(<i>Eurycea chisholmensis</i>)</u>	Aquatic. The Northern Segment of the Edwards Aquifer, which is a karst aquifer characterized by open chambers such as caves, fractures, and other cavities that were formed either directly or indirectly by dissolution of subsurface rock formations. (USFWS 2014, Pg. 10237)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2014. <u>Determination of Threatened Species Status for the Georgetown Salamander and Salado Salamander Throughout Their Ranges</u> . Final Rule
<u>San Marcos salamander</u> <u>(<i>Eurycea nana</i>)</u>	Aquatic Spring Lake. Found among aquatic plants on the bottom of the lake. Found under stones in sand and gravel areas. Must have flowing water (from springs flowing into Spring Lake). (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1996. San Marcos and Comal Springs and associated aquatic ecosystems (Revised) recovery plan. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/960214.pdf
<u>Sea turtle, green</u> <u>(<i>Chelonia mydas</i>)</u>	Green turtles are primarily restricted to tropical and subtropical waters. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found from Massachusetts to Texas and in the U.S. Virgin Islands and Puerto Rico...Seagrasses are the principal dietary	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

Species	Habitat	Rationale	Source
	component of juvenile and adult green turtles throughout the Wider Caribbean region (Bjorndal, 1995). (NMFS, NOAA 1998, p. 46694)		
<u>Sea turtle, hawksbill</u> <u>(<i>Eretmochelys imbricata</i>)</u>	The hawksbill turtle occurs in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Coral reefs, like those found in the waters surrounding Mona and Monito Islands, are widely recognized as the primary foraging habitat of juvenile, subadult, and adult hawksbill turtles. This habitat association is directly related to the species' highly specific diet of sponges (Meylan, 1988). Hawksbills depend on coral reefs for food and shelter; therefore, the condition of reefs directly affects the hawksbill's well-being. (NMFS, NOAA 1998, p. 46695)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf
<u>Sea turtle, Kemp's ridley</u> <u>(<i>Lepidochelys kempii</i>)</u>	This life history pattern is characterized by three basic ecosystem zones: (1) Terrestrial zone (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) Neritic zone - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2011, p. I-8)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2011. Bi-national recovery plan for the kemp's ridley sea turtle. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

Species	Habitat	Rationale	Source
<u>Sea turtle leatherback</u> <u>(<i>Dermochelys coriacea</i>)</u>	Leatherbacks are able to take advantage of a wide variety of marine ecosystems (reviewed by Saba 2013; see NOAA large marine ecosystem website: http://www.lme.noaa.gov/). Within these ecosystems, various oceanic features such as water temperature, downwelling, Ekman upwelling, sea surface height, chlorophyll-a concentration, and mesoscale eddies affect the presence of leatherbacks (Bailey et al. 2013; Benson et al. 2011). The physical characteristics observed within these marine ecosystems also affect the distribution and abundance of leatherback prey (reviewed by Saba 2013). (NMFS, NOAA 2013, p. 20-22).	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2013. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/090116.pdf
<u>Shiner, Arkansas River</u> <u>(<i>Notropis girardi</i>)</u>	Wilde et al. (2000) found no obvious selection for or avoidance of any particular habitat type (i.e., main channel, side channel, backwaters, and pools) by Arkansas River shiner. Arkansas River shiners did tend to select side channels and backwaters slightly more than expected based on the availability of these habitats (Wilde et al. 2000). Likewise, they appeared to make no obvious selection for, or avoidance of, any particular substrate type. Substrates (i.e., the river bed) in the Canadian River in New Mexico and Texas were predominantly sand, however, the Arkansas River shiner was observed to occur over silt slightly more than	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2005. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/recovery_plan/950830.pdf

Species	Habitat	Rationale	Source
	<p>expected based on the availability of this substrate (Wilde et al. 2000) ; preferred habitat for the Arkansas River shiner is the mainstem of larger plains rivers... historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin (Gilbert 1980). Adults are uncommon in quiet pools or backwaters lacking streamflow, and almost never occurred in habitats having deep water and bottoms of mud or stone (Cross 1967) (US FWS 2005).</p>		
<p><u>Shiner, blue</u> <u>(<i>Cyprinella</i></u> <u><i>caerulea</i>)</u></p>	<p>The blue shiner primarily occupies second to fourth order, moderate gradient streams within the Ridge and Valley and Piedmont physiographic provinces of Alabama, Georgia, and Tennessee (Smith-Vaniz 1968, Ramsey 1976, Krotzer 1984, Ramsey and Pierson 1986, Pierson and Krotzer 1987, Mayden 1989, Pierson et al. 1989, Boschung 1992, Etnier and Starnes 1993, Dobson 1994). Most watersheds where it is found are predominately forested, and agriculture and urban development are minimal. For example in Alabama, land cover in the Choccolocco watershed is 66 percent forest, 20 percent pasture, and 13 percent agriculture...It prefers a sand or sand and gravel substrate sometimes with cobble, low to moderate velocity current, and a depth of about 0.15 to 1 meters (0.5 to 3 feet)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>US FWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950830.pdf</p>

Species	Habitat	Rationale	Source
	(Gilbert et al. 1979; Krotzer 1984, Pierson and Krotzer 1987, Dobson 1994) (US FWS 1995, p. 3-4)		
<u>Shiner, smalleye</u> <u>(<i>Notropis buccula</i>)</u>	Occur in fairly shallow, flowing water, often less than 0.5 m deep with sandy substrates (US FWS 2014, p. 45252)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2014-08-04/pdf/2014-17694.pdf
<u>Snake, copperbelly water</u> <u>(<i>Nerodia erythrogaster neglecta</i>)</u>	Copperbellies are generally affiliated with wetlands and prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (<i>Cephalanthus occidentalis</i>), emergent wetlands, or the margins of palustrine open water wetlands. Buttonbrush swamps are used as basking areas. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Uplands are also important. (US FWS, 2008, p. 17-18). Critical Habitat has not been designated for the snake because of concerns related to illegal collection (US FWS, 2008, p. 20).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2008. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/081223.pdf
<u>Spectaclecase (mussel)</u> <u>(<i>Cumberlandia monodonta</i>)</u>	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf

Species	Habitat	Rationale	Source
	found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).		
<u>Spider, spruce-fir moss</u> <i>(Microhexura montivaga)</i>	Typical habitat appears to be associated with moist, well-drained moss mats growing on rocks and boulders in well-shaded situations in mature high-elevation conifer forests dominated by Fraser fir, <i>Abies fraseri</i> , often with scattered red spruce, <i>Picea rubens</i> . (US FWS 1998, p. iii)	The proposed dicamba DGA uses are not expected to overlap with high-elevation conifer forests.	USFWS, 1998, Recovery Plan. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
<u>Southwestern willow flycatcher</u> <i>(Empidonax traillii extimus)</i>	Breeding: Forested wetlands or scrub-shrub wetlands-dense riparian habitat of rivers, swamps, wetlands, lakes (USFWS 2002, p. iv). Wintering: brushy savanna edges, second growth, shrubby clearings and pastures, woodlands near water (USFWS 2002, p. iv).	Recommend off-field status for row crop agriculture. According to the Critical Habitat designation document (USFWS 2013) essential characteristics for southwestern will flycatcher habit include riparian areas for flowing stream that support expansive riparian vegetation areas. Riparian trees and understory species are viewed as essential elements of flycatcher habitat. Row crop soy and corn are monocultures of non-riparian vegetation and consequently not suitable habitat for this species.	USFWS 2002. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plans/2002/020830c.pdf USFWS. 2013. Designation of Southwestern Willow Flycatcher Critical Habitat: Final Rule. Federal Register Vol. 78 No.2.

Species	Habitat	Rationale	Source
<u>Sperm whale</u> (<i>Physeter catodon</i> (= <i>macrocephalus</i>))	Ocean/ Water depth of 1968 feet or more (NMFS 2012)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS. 2012. Sperm whales (<i>Physeter catodon</i>). National Marine Fisheries Service. Available online at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm
<u>Squirrel, Carolina northern flying</u> (<i>Glaucomys sabrinus coloratus</i>)	Species composition of the occupied forest may vary in different locations, some combination of hardwoods and conifers (particularly spruce and fir) appears essential to support these animals...Food sources for the Carolina northern flying squirrel include fungi, lichens, staminate cones, insects, and other animal matter (US FWS 1990, p. 6-7)	The proposed dicamba DGA uses are not expected to overlap with hardwood and conifer forests.	USFWS. 1990. Recovery Plan for Appalachian Northern Flying Squirrels. United States Fish and Wildlife Service.
<u>Stirrupshell</u> (<i>Quadrula stapes</i>)	Habitat is the Tombigbee River, characterized by an increasing number of sand and gravel shoals and decreasing channel size in the upper portions (US FWS, 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Sturgeon, gulf</u> (<i>Acipenser oxyrinchus desotoi</i>)	The Gulf sturgeon is an Anadromous fish which migrates from salt water into large coastal rivers to spawn and spend the warm months. The majority of its life is spent in fresh water (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950922.pdf
<u>Sturgeon, pallid</u> (<i>Scaphirhynchus albus</i>)	Habitat is the bottom in swift waters of large, turbid, free-flowing rivers, often over sand substrates, but other substrates include at least gravel and rock. Sloughs, chutes, and side channels that transition from floodplain to the main channels are apparently important as spawning, nursery, and feeding areas.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Pallid%20Sturgeon%20Recovery%20Plan%20First%20Revision%20signed%20version%20012914_3.pdf USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1059.pdf

Species	Habitat	Rationale	Source
	Within the subject states, this habitat occurs in the Mississippi and Missouri rivers (US FWS, 1993, pp 6-7). Within this habitat, they tend to select main channel habitats in the Mississippi River, and main channel habitats with islands or sand bars in the upper Missouri River (US FWS, 2007, p. 8). They do not typically occur in impounded areas due to lower flows and other hydrologic factors, nor where channel stabilization has reduced channel meandering and access to floodplain areas (US FWS, 2007, p. 38).		
<u>Tem. least interior pop. (<i>Sterna antillarum</i>)</u>	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting occurs along river banks (US FWS, 1990, p. 20).	The proposed dicamba DGA uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf
<u>Texas blind salamander (<i>Typhlomolge rathbuni</i>)</u>	Aquatic, subterranean (caves) (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1996. San Marcos and Comal Springs and associated aquatic ecosystems (Revised) recovery plan. United States Fish and Wildlife Service. Available online at:

Species	Habitat	Rationale	Source
			http://ecos.fws.gov/docs/recovery_plan/960214.pdf
Warbler, Kirtland's (<i>Setophaga kirtlandii</i>)	<p>Forests (US FWS 1985, p. 8)</p> <p>During breeding, Kirtland's warblers are located in Michigan. Its wintering grounds are located in the Bahamas, where it spends 8 months of the year (September-April). (US FWS 1985)</p> <p>In migration, the bird travels a fairly direct route between its nesting and wintering ranges, entering and leaving the continent at the coast of North and South Carolina (USFWS 1985, p. 5).</p> <p>With one or few exceptions, all nests have been found on Grayling sand soil (USFWS 1985, p. 7).</p>	The proposed dicamba DGA uses are not expected to overlap with forests.	<p>USFWS. 1985 Kirtland's Warbler Recovery Plan. Updated.</p> <p>http://ecos.fws.gov/docs/recovery_plan/850930.pdf</p>
Whale, finback (<i>Balaenoptera physalus</i>)	Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally.	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm
Whale, humpback (<i>Megaptera novaeangliae</i>)	<p>During migration, humpbacks stay near the surface of the ocean.</p> <p>While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found</p>	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm

Species	Habitat	Rationale	Source
	<p>in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.</p> <p>Humpback feeding grounds are in cold, productive coastal waters.</p>		
<u>Wartyback,</u> <u>white</u> <u>(pearlymussel)</u> <u>(<i>Plethobasus</i></u> <u><i>cicatricosus</i>)</u>	<p>The white wartyback has undergone a substantial range reduction and is considered to be possibly extinct. It was historically distributed in the Wabash, Ohio, Kanawha, Cumberland, Holston, and Tennessee Rivers of the Ohio, Cumberland, and Tennessee River systems; however, no live specimens have been recovered from these drainages since the early 1900s). The white wartyback may still exist in a short reach of the Tennessee River below Pickwick Dam. No living populations have been found in numerous surveys conducted in the Tennessee River since the 1960s; however, fresh dead specimens were collected in 1979 and 1982 below Pickwick Dam near Savannah, Tennessee. If this species still exists, the viability of remaining populations is extremely threatened</p> <p>The white wartyback is a riffle species that is typically found in large rivers in gravel substrates.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with coastal waters.</p>	<p>USFWS, 1984, Recovery Plan White Warty-backed Pearlymussel http://ecos.fws.gov/docs/recovery_plan/060313h.pdf http://ecos.fws.gov/docs/life_histories/F00M.html</p>

Species	Habitat	Rationale	Source
<u>Woodpecker</u> <u>red-cockaded</u> <u>Entire (<i>Picoides</i></u> <u><i>borealis</i>)</u>	Habitat: Forest, Savannah (open pine woodlands and savannahs with large old pines) (US FWS 2003, p. x) Habitat size (home range): 116 – 357 acres (US FWS 2003, p. 49)	Proposed dicamba DGA uses are not expected to overlap with forest or savannah.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf
Wood stork (<i>Mycteria americana</i>)	Freshwater and estuarine Wetlands. (US FWS 1986, p. iii). Wood storks breed in FL, GA and SC. They migrate south in winter (US FWS 1986, p. 2). Require a mosaic of wetlands with varying climatological and seasonal conditions around colonies and within the wintering habitat in the coastal plain of the Southeast U.S. (US FWS 2006, p. 12).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970127.pdf USFWS. 2006. Five year Review. http://ecos.fws.gov/docs/five_year_review/doc1115.pdf
<u>Noonday globe</u> (<i>Patera clarki nantahala</i>)	Found mainly on the southeast side of the Nantahala River Gorge. Area is strikingly different than the surrounding area, very steep, with a mix of various hardwood trees and hemlock, and has a rich herbaceous undergrowth. The area is interrupted frequently by small streams, waterfalls, seeps, springs, and often shaded. The forest floor has a thick humus layer with much exposed rock, where the snail is most abundant on and around moist rock outcrops, but also found in thick leaf litter and humus layers around	The proposed dicamba DGA uses are not expected to overlap with forests.	Noonday Globe <i>Patera</i> (= <i>Mesodon</i>) <i>clarki nantahala</i> 5-Year Review: Summary and Evaluation, Page 4 Available at: http://ecos.fws.gov/docs/five_year_review/doc4295.pdf

	the base of ferns and underneath rhododendron and dog hobbe, and other moist habitats. Moisture is key.		
<u>Phantom springsnail</u> (<i>Pyrgulopsis texana</i>)	<p>The Phantom springsnail occurs only in the four remaining desert spring outflow channels associated with the San Solomon Spring system (San Solomon, Phantom, Giffin, and East Sandia springs).</p> <p>Habitat of the species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41). They are also commonly found attached to plants, particularly in dense stands of submerged vegetation (Chara sp.). Field and laboratory experiments have suggested Phantom springsnails prefer substrates harder and larger in size (Bradstreet 2011, p. 91).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41236. Available at:</p> <p>http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf</p>
<u>Phantom tryonia</u> (<i>Tryonia cheatumi</i>)	The Phantom tryonia occurs only in the four remaining desert spring outflow channels associated with the San	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41236-41237. Available at:</p> <p>http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf</p>

	<p>Solomon Spring system (San Solomon, Phantom, Giffin, and East Sandia springs) (Taylor 1987, p. 40; Allan 2011, p. 1; Lang 2011, entire).</p> <p>The species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41), and they are also commonly found attached to plants, particularly in dense stands of submerged vegetation (<i>Chara</i> sp.).</p>		
<u>Armored snail (<i>Pyrgulopsis</i> (= <i>Marstonia</i>) <i>pachyta</i>)</u>	<p>The armored snail is currently only known from Limestone and Piney Creeks, Limestone County, Alabama, and appears to be most abundant in submerged root masses and bryophytes (non-vascular land plants, e.g. mosses) along the creek edges, but also may occur on rocks and leafy/woody debris, and on other aquatic macrophytes (aquatic plants) (Garner 2004a, Haggerty and Garner 2007, 2008).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2010. Armored Snail (<i>Marstonia pachyta</i>) 5-Year Review. Page 2. Available at: http://ecos.fws.gov/docs/five_year_review/doc3288.pdf</p>
<u>Pecos assiminea snail (<i>Assiminea</i> <i>pecos</i>)</u>	<p>The Pecos assiminea requires saturated, moist soil at stream or spring-run margins and is found in wet mud or beneath mats of vegetation, usually within 1 inch (in) (2 to 3 centimeters (cm)) of flowing water. Spring complexes that</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2011. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule. Page 33039. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf</p>

	<p>contain flowing water create saturated soils that provide the specific habitat needed for population growth, sheltering, and normal behavior of the species. Although this snail seldom occurs immersed in water, the species cannot withstand permanent drying of springs or spring complexes. Consequently, wetland plant species are required to provide leaf litter (dead leaf material), shade, and appropriate microhabitat. Plant species such as <i>Scirpus americanus</i> (American three-square), <i>Eleocharis spp.</i> (spike rush), <i>Distichlis spicata</i> (inland saltgrass), and <i>Juncus spp.</i> (rushes) provide the appropriate cover and shelter required by Pecos assiminea (NMDGF 2005, p. 13).</p>		
<p><u>Diamond Y Spring snail</u> (<u><i>Pseudotryonia adamantina</i></u>)</p>	<p>Habitat of the species is primarily soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush (<i>Scirpus americanus</i>) and saltgrass (<i>Distichlis spicata</i>) (Taylor 1987, p. 38; Echelle et al. 2001, p.5).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41237. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf</p>

<u>Tulotoma snail</u> (<u>Tulotoma</u> <u>magnifica</u>)	Tulotoma occur in cool, well-oxygenated, clean, free-flowing streams, including rivers and the lower portions of the rivers' larger tributaries (Herschler et al. 1990, p. 822). This species is generally found in shoals (a shallow place in a body of water) and riffles (a rocky shoal lying just below the surface of the water) with moderate to strong currents. Although this species is typically associated with shoals and riffles, it inhabits rivers that rise and fall, and tulotoma have been collected at depths more than 5 meters (m) (15 feet (ft)) (Hartfield 1991, p. 7). The species is strongly associated with boulder, cobble, and bedrock stream bottoms and is generally found clinging tightly to the underside of large rocks or between cracks in bedrock (Christman et al. 1996, p. 28). Historical habitats included large coastal plain river, large high-gradient rivers, and multiple upland tributary streams.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. Final Reclassification of the Tulotoma Snail From Endangered to Threatened. Page 31867. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-06-02/pdf/2011-13687.pdf
<u>Gonzales springsnail</u> (<u>Tryonia</u> <u>circumstriata</u>)	Habitat of the species is primarily soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41238. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf

	saltgrass (Taylor 1987, p. 38; Echelle et al. 2001, p. 5).		
<u>Lacy elimia (snail) (<i>Elimia crenatella</i>)</u>	<p>Lacy elimia typically inhabit highly oxygenated waters on rock shoals and gravel bars.</p> <p>Currently, the lacy elimia is only known to survive in three Coosa River tributaries-- Cheaha, Emauhee, and Weewoka Creeks, Talladega County, Alabama (Bogan and Pierson, 1993a).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers or other water bodies.	<p>USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 8.</p> <p>Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf</p>
<u>Rough hornsnail (<i>Pleurocera foremani</i>)</u>	Rough hornsnails are primarily found on gravel, cobble, bedrock, and mud in moderate currents. They have been collected at depths of 1 m (3.3 ft) to 3 m (9.8 ft) (Hartfield 2004, p. 132). The species appears to tolerate low-to- moderate levels of silt deposition (Sides 2005, p. 127).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2010. Determination of Endangered Status for the Georgia Pigtoe Mussel, Interrupted Rocksnail, and Rough Hornsnail and Designation of Critical Habitat; Final Rule. Page 67514.</p> <p>Available at: http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27417.pdf#page=2</p>
<u>Cylindrical lioplax (snail) (<i>Lioplax cyclostomaformis</i>)</u>	<p>The cylindrical lioplax is currently known only from approximately 24 kilometers (km) (15 miles (mi)) of the Cahaba River above the Fall Line in Shelby and Bibb counties, Alabama (Bogan and Pierson, 1993b).</p> <p>Habitat for the cylindrical lioplax is unusual for the genus,</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 4.</p> <p>Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf</p>

	as well as for other genera of viviparid snails. It lives in isolated mud deposits found under large rocks in the rapid flowing sections of stream and river shoals.		
<u>Flat pebblesnail</u> <u>(<i>Lepyrium showalteri</i>)</u>	<p>The flat pebblesnail is currently known from One site on the Little Cahaba River, Bibb County, and from a single shoal series on the Cahaba River above the Fall Line, Shelby County, Alabama (Bogan and Pierson, 1993b).</p> <p>The flat pebblesnail is found attached to clean, smooth stones in rapid currents of river shoals.</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 6. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf
<u>Painted rocksnail</u> <u>(<i>Leptoxis taeniata</i>)</u>	<p>The painted rocksnail is currently known from the lower reaches of three Coosa River tributaries-- Choccolocco Creek, Talladega County; Buxahatchee Creek, Shelby County (Bogan and Pierson, 1993a); and Ohatchee Creek, Calhoun County, Alabama (Pierson in litt, 1993).</p> <p>Painted rocksnails are found attached to cobble, gravel, or other hard substrates in the strong currents of riffles (a shallow area in a streambed that causes ripples in the water) and shoals. Adult rocksnails move very little, and females probably glue</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 10. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf

	their eggs to stones in the same habitat (Goodrich, 1922).		
<u>Plicate rocksnail</u> (<i>Leptoxis plicata</i>)	Plicate rocksnails inhabit shallow gravel and cobble shoals in flowing waters.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 14. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf
<u>Round rocksnail</u> (<i>Leptoxis ampla</i>)	<p>The round rocksnail is currently known from a shoal series in the Cahaba River, Bibb and Shelby counties, Alabama, and from the lower reach of the Little Cahaba River, and the lower reaches of Shade and Six-mile creeks in Bibb County, Alabama (Bogan and Pierson, 1993b).</p> <p>Painted rocksnails are found attached to cobble, gravel, or other hard substrates in the strong currents of riffles (a shallow area in a streambed that causes ripples in the water) and shoals. Adult rocksnails move very little, and females probably glue their eggs to stones in the same habitat (Goodrich, 1922).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 12. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf
<u>Slender campeloma</u> (<i>Campeloma decampi</i>)	<i>Campeloma decampi</i> is typically found burrowing in soft sediment (sand and/or mud) or detritus. It does not appear abundant at any site, and the spotty distribution appears	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2000. Endangered Status for the Armored Snail and Slender Campeloma; Final Rule. Page 10034. Available at: http://ecos.fws.gov/docs/federal_register/fr3525.pdf

	consistent with other <i>Campeloma</i> species		
<u>Interrupted (=Georgia) Rocksnail (<i>Leptoxis foremani</i>)</u>	Rocksnailes live in shoals, riffles, and reefs (bedrock outcrops) of small to large rivers. Their habitats are generally subject to moderate currents during low flows and strong currents during high flows. These snails live attached to bedrocks, boulders, cobbles, and gravel and tend to move little, except in response to changes in water level. They lay their adhesive eggs within the same habitat (Johnson 2004, p.116).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2010. Determination of Endangered Status for the Georgia Pigtoe Mussel, Interrupted Rocksnail, and Rough Hornsnail and Designation of Critical Habitat; Final Rule. Page 67513. Available at: http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27417.pdf#page=2
<u>Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>)</u>	River/stream(moderate to fast flow), depth of few inches to few feet, inorganic substrate. (USFWS 2009, p 5) 1st, 2nd and 3rd order perennial streams (USFWS 2006, p 22)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS, Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>) 5 Year Review, 2009 Available at: http://ecos.fws.gov/docs/five_year_review/doc2584.pdf US FWS, Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>) Recovery Plan, 2006 Available at: http://ecos.fws.gov/docs/recovery_plan/060928a.pdf
<u>Coffin Cave mold beetle (<i>Batrisodes texanus</i>)</u>	Troglobitic habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Coffin Cave Mold Beetle (<i>Batrisodes texanus</i>) 5-Year Review: Summary and Evaluation Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3017.pdf

<u>Kretschmarr Cave mold beetle</u> (<i>Texamaurops reddelli</i>)	Their habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Tooth Cave Spider (<i>Neoleptoneta myopica</i>), Kretschmarr Cave Mold Beetle (<i>Texamaurops reddelli</i>), and Tooth Cave Pseudoscorpion (<i>Tartarocreagris texana</i>) 5-Year Review: Summary and Evaluation Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3018.pdf
<u>Tooth Cave ground beetle</u> (<i>Rhadine persephone</i>)	They spend their entire lives underground and are endemic to karst formations (caves, sinkholes, and other subterranean voids).	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas Page III Available at: http://ecos.fws.gov/docs/recovery_plan/940825.pdf
<u>Comal Springs riffle beetle</u> (<i>Heterelmis comalensis</i>)	High quality unpolluted groundwater and spring outflows that have low levels of salinity and turbidity. High-quality discharge water from springs and adjacent subterranean areas also help sustain habitat components, such as riparian vegetation that are essential to the Peck's cave amphipod, Comal Springs dryopid beetle, and Comal Springs riffle beetle. The two beetle species are thought to require water with adequate levels of dissolved oxygen for respiration (Brown 1987, p. 260; Arsuffi 1993, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2006. Designation of Critical Habitat for the Peck's Cave Amphipod, Comal Springs Dryopid Beetle, and Comal Springs Riffle Beetle; Proposed Rule. Page 40592. Available at: http://www.gpo.gov/fdsys/search/citation/result?FR.action=federalRegister.volume=2006&federalRegister.page=40588&publication=FR
<u>Comal Springs dryopid beetle</u> (<i>Stygoparnus comalensis</i>)	High quality unpolluted groundwater and spring outflows that have low levels of salinity and turbidity. High-quality discharge water from springs and adjacent subterranean areas also	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2006. Designation of Critical Habitat for the Peck's Cave Amphipod, Comal Springs Dryopid Beetle, and Comal Springs Riffle Beetle; Proposed Rule. Page 40592. Available at:

	help sustain habitat components, such as riparian vegetation that are essential to the Peck's cave amphipod, Comal Springs dryopid beetle, and Comal Springs riffle beetle. The two beetle species are thought to require water with adequate levels of dissolved oxygen for respiration (Brown 1987, p. 260; Arsuffi 1993, p. 18).		http://www.gpo.gov/fdsys/search/citation.result?FR.action=federalRegister.volume=2006&federalRegister.page=40588&publication=FR
<u>Saint Francis' satyr butterfly</u> (<i>Neonympha mitchellii francisci</i>)	The habitat occupied by this satyr consists primarily of wide wet meadows dominated by a high diversity of sedges (<i>Carex</i> spp.) and other wetland graminoids	The proposed dicamba DGA uses are not expected to overlap with wet meadows.	US FWS-Recovery Plan for Saint Francis' Satyr Butterfly Page 2 Available at: http://ecos.fws.gov/docs/recovery_plan/960423.pdf
<u>[Unnamed] ground beetle</u> (<i>Rhadine infernalis</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi (comments - 7). Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Helotes mold beetle</u> (<i>Batrisodes venyivi</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi (comments - 7). Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>[Unnamed] ground beetle</u> (<i>Rhadine exilis</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi (comments - 7). Available at:

	caves, produced by dissolution of bedrock)		http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Bee Creek Cave harvestman</u> (<i>Texella reddelli</i>)	Bee Creek Cave Harvestman inhabit limestone caves. They are only able to survive in caves that maintain stable temperatures and humidity (close to 100%). They have been found in caves both on the north and south side of the Colorado river. They live in 'karst' type of terrain , which is formed by "dissolution of calcium carbonate from limestone bedrock by mildly acidic groundwater.	The proposed dicamba DGA uses are not expected to overlap with caves.	USFWS-Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas U.S. Fish and Wildlife Service Page III Available at: http://ecos.fws.gov/docs/recovery_plan/940825.pdf
<u>Bone Cave harvestman</u> (<i>Texella reyesi</i>)	Caves and mesocavernous voids in karst limestone	The proposed dicamba DGA uses are not expected to overlap with caves.	USFWS Bone Cave Harvestman 5-Year Review Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3016.pdf
<u>Tooth Cave pseudoscorpion</u> (<i>Tartarocreagris texana</i>)	Their habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock). There are currently four caves that support the Tooth Cave pseudoscorpion (<i>Tartarocreagris texana</i>).	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Tooth Cave Spider (<i>Neoleptoneta myopica</i>), Kretschmarr Cave Mold Beetle (<i>Texamaurops reddelli</i>), and Tooth Cave Pseudoscorpion (<i>Tartarocreagris texana</i>) 5-Year Review: Summary and Evaluation Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3018.pdf

<u>Tooth Cave Spider</u> (<i>Lepioneta myopica</i>)	Their habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock). There are currently six caves known to contain the Tooth Cave spider (<i>Neoleptoneta myopica</i>).	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS Tooth Cave Spider, Kretschmarr Cave Mold Beetle, and Tooth Cave Pseudoscorpion 5-Year Review Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3018.pdf
<u>Cokendolpher Cave Harvestman</u> (<i>Texella cokendolpheri</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Government Canyon Bat Cave Spider</u> (<i>Neoleptoneta microps</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Madla's Cave Meshweaver</u> (<i>Cicurina madla</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf

<u>Robber Baron Cave Meshweaver</u> (<i>Cicurina baronia</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Government Canyon Bat Cave Meshweaver</u> (<i>Cicurina vespera</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Braken Bat Cave Meshweaver</u> (<i>Cicurina venii</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Peck's cave amphipod</u> (<i>Stygobromus</i> (= <i>Stygonectes</i>) <i>pecki</i>)	High quality unpolluted groundwater and spring outflows that have low levels of salinity and turbidity. High-quality discharge water from springs and adjacent subterranean areas also help sustain habitat components, such as riparian vegetation that are essential to the Peck's cave amphipod, Comal Springs dryopid beetle, and Comal Springs riffle beetle. The two beetle species	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2006. Designation of Critical Habitat for the Peck's Cave Amphipod, Comal Springs Dryopid Beetle, and Comal Springs Riffle Beetle; Proposed Rule. Page 40592. Available at: http://www.gpo.gov/fdsys/search/citation.result?FR.action=federalRegister.volume=2006&federalRegister.page=40588&publication=FR

	are thought to require water with adequate levels of dissolved oxygen for respiration (Brown 1987, p. 260; Arsuffi 1993, p. 18).		
<u>Alabama cave shrimp</u> (<i>Palaemonias alabamae</i>)	Silt-bottomed cave pools (USFWS 1997)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS, Alabama Cave Shrimp (<i>Palaemonias alabamae</i>) 5 year review, 2006. Available at: http://ecos.fws.gov/docs/five_year_review/doc747.pdf US FWS, Alabama Cave Shrimp (<i>Palaemonias alabamae</i>) recovery plan, 1997. Available at: http://ecos.fws.gov/docs/recovery_plan/970904.pdf
<u>Kentucky cave shrimp</u> (<i>Palaemonias ganteri</i>)	Very specific habitat requirements- large, base level passages of caves characterized by slow flow, abundant organic matter, and coarse to fine grain sand and coarse silt sediments.	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS, Kentucky Cave shrimp completed 5-year review, 2010. Page 5. Available at: http://ecos.fws.gov/docs/five_year_review/doc3203.pdf
<u>Diminutive Amphipod</u> (<i>Gammarus hyalleloides</i>)	Amphipods in the <i>Gammarus pecos</i> species complex occur only in desert spring outflow channels on substrates, often within interstitial spaces on and underneath rocks and within gravels (Lang et al. 2003, p. 49) and are most commonly found in microhabitats with flowing water. They are also commonly found in dense stands of submerged vegetation (Cole 1976, p. 80). Because of their affinity for constant water	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41238. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf

	temperatures, they are most common in the immediate spring outflow channels, usually only a few hundred meters downstream of spring outlets.		
<u>Alabama pearlshell</u> (<i>Margaritifera marrianae</i>)	The Alabama pearlshell typically inhabits small headwater streams with mixed sand and gravel substrates, occasionally in sandy mud, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule. Page 61667</u>
<u>Altamaha Spinemussel</u> (<i>Elliptio spinosa</i>)	This spinymussel is considered a “big river” species; is associated with stable, coarse-to-fine sandy sediments of sandbars, sloughs, and mid-channel islands; and appears to be restricted to swiftly flowing water (Sickel 1980, p. 12).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. <u>Endangered Status for the Altamaha Spinemussel and Designation of Critical Habitat: Final Rule. Page 62928</u>
<u>Carolina heelsplitter</u> (<i>Lasmigona decorata</i>)	It has been recorded from a variety of substrates (including mud, clay, sand, gravel, and cobble/boulder/bedrock) without significant silt accumulations, along stable, well-shaded stream banks (Keferl and Shelly 1988, Keferl 1991). However, individuals have also been found near the center of the stream channel in relatively silt-free substrates comprised primarily of a mixture of sand, gravel, and cobble, with scattered areas of	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F02L.html

	exposed boulders/ bedrock (J. Fridell personal observation, 1995).		
<u>Chipola slabshell</u> (<i>Elliptio chipolaensis</i>)	The Chipola slabshell inhabits silty sand substrates of large creeks and the main channel of the Chipola River in slow to moderate current (Williams and Butler 1994). Specimens are generally found in sloping bank habitats. Nearly 70 percent of the specimens found during the status survey were associated with a sandy substrate (Brim Box and Williams 2000).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
<u>Choctaw bean</u> (<i>Villosa choctawensis</i>)	It is found in medium creeks to medium rivers in stable substrates of silty sand to sandy clay with moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Final rule. Page 61669</u>
<u>Cracking pearlymussel</u> (<i>Hemistena lata</i>)	The cracking pearlymussel inhabits streams of moderate size on gravel riffles where it is often deeply buried in the substrate (Bogan and Parmalee 1983). Substrate preferences include sand, gravel, and cobble in high velocity areas and mud and sand in slower moving waters (Gordon and Layzer 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F01X.html

<u>Cumberland elktoe</u> (<u>Alasmidonta</u> <u>atropurpurea</u>)	This species inhabits medium-sized rivers and may extend into headwater streams where it is often the only mussel present (Gordon and Layzer 1989, Gordon 1991). Gordon and Layzer (1989) reported that the species appears to be most abundant in flats, which were described by Gordon (1991) as shallow pool areas lacking the bottom contour development of typical pools, with sand and scattered cobble/boulder material, relatively shallow depths, and slow (almost imperceptible) currents. They also report the species from swifter currents and in areas with mud, sand, and gravel substrates.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2004. <u>Cumberland and Tennessee River Mussels (5 spp.)</u> Page 18.
<u>Dark pigtoe</u> (<u>Pleurobema</u> <u>furvum</u>)	Sand/gravel/cobble shoals and rapids in small rivers and large streams.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2000. <u>Recovery Plan for the Mobile River Basin (15 species)</u> . Page 53
<u>Dwarf wedgemussel</u> (<u>Alasmidonta</u> <u>heterodon</u>)	The dwarf wedge mussel lives on muddy sand, sand, and gravel bottoms in creeks and rivers of varying sizes, in areas of slow to moderate current and little silt deposition.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1993. <u>Dwarf Wedge Mussel</u> recovery plan. Page 3.
<u>Fat three-ridge (mussel)</u> (<u>Amblema</u> <u>neislerii</u>)	The fat three-ridge inhabits the main channel of small to large rivers in slow to moderate current. Substrate used by this mussel varies from gravel to cobble to a	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. <u>Recovery Plan for 7 mussels</u> . Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf

	mixture of sand and sandy mud (Williams and Butler 1994). Brim Box and Williams (2000) found 60 percent of the specimens were located in a sandy silt substrate.		
<u>Flat pigtoe</u> (<i>Pleurobema marshalli</i>)	The flat pigtoe, like other Tombigbee River system mussels, inhabits moderate to large rivers with moderate to swift current. Its preferred habitat is riffle-run or shoal areas with stable substrates ranging from sandy gravel to gravel-cobble (Stanbery 1976, 1980, 1983). Unionids collected from the Tombigbee River system have been collected in water up to 0.7 meters deep (USFWS 1987).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F013.html
<u>Fuzzy pigtoe</u> (<i>Pleurobema strodeanum</i>)	The fuzzy pigtoe is found in medium creeks to medium rivers in stable substrates of sand and silty sand with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Final rule. Page 61673</u>
<u>Gulf moccasinshell</u> (<i>Medionidus penicillatus</i>)	The Gulf moccasinshell inhabits the channels of small to medium-sized creeks to large rivers with sand and gravel or silty sand substrates in slow to moderate currents (Williams and Butler 1994; Garner, pers. comm. 2003).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. <u>Recovery Plan for 7 mussels. Page 43.</u> http://ecos.fws.gov/docs/recovery_plan/030930.pdf

Heavy pigtoe (<i>Pleurobema latianum</i>)	The heavy pigtoe, like other Tombigbee River system mussels, inhabits moderate to large rivers with moderate to swift current. Its preferred habitat is riffle-run or shoal areas with stable substrates ranging from sandy gravel to gravel-cobble (Stanbery 1976, 1980, 1983). Unionids collected from the Tombigbee River system have been collected in water up to 0.7 meters deep (USFWS 1987).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F014.html
James spinymussel (<i>Pleurobema collina</i>)	This species lives in stream sites that vary in width from 10-75 feet and depth of 1/2 to 3 feet. It requires a slow to moderate water current with clean sand and cobble bottom sediments. The James spinymussel is limited to areas of unpolluted water, and may be more susceptible to competition from exotic clam species when its habitat is disturbed (Clark and Neves 1984, USFWS 1990).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F025.html
Narrow pigtoe (<i>Fusconaia escambia</i>)	It is found in medium creeks to medium rivers, in stable substrates of sand, sand and gravel, or silty sand, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule, Page 61671

Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)	The Ochlockonee moccasinshell inhabits large creeks and the Ochlockonee River main stem in areas with current. Typical substrates are sand with some gravel (Williams and Butler 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Oval pigtoe (<i>Pleurobema pyriforme</i>)	The oval pigtoe occurs in small to medium-sized creeks to small rivers where it inhabits silty sand to sand and gravel substrates, usually in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Stream channels appear to offer the best habitat for this species.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Purple bankclimber (mussel) (<i>Elliptioideus sloatianus</i>)	The purple bankclimber inhabits small to large river channels in slow to moderate current over sand or sand mixed with mud or gravel substrates (Williams and Butler 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Ring pink (mussel) (<i>Obovaria retusa</i>)	The ring pink inhabits gravel and sandy substrates in large rivers of the Ohio River basin	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS, 1991. Ring Pink Mussel Recovery Plan. Page 4. http://ecos.fws.gov/docs/recovery_plan/910325.pdf
Round Ebonyshell (<i>Fusconaia rotulata</i>)	It occurs in small to medium rivers, typically in stable substrates of sand, small gravel, or sandy mud in slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668

Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)	The shinyrayed pocketbook inhabits small to medium-sized creeks, to rivers in clean or silty sand substrates in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Specimens are often found in the interface of stream channel and sloping bank habitats, where sediment particle size and current strength are transitional. Clench and Turner (1956) noted it preferred small creeks and spring-fed rivers.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Southern acornshell (<i>Epioblasma othcaloogensis</i>)	The southern acornshell was historically restricted to shoals in small rivers to Small streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2000. Recovery Plan for the Mobile River Basin (15 species). Page 57
Southern kidneyshell (<i>Ptychobranhus jonesi</i>)	It is typically found in medium creeks to small rivers in firm sand substrates with slow to moderate current (Williams et al. 2008, pp. 625).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668
Southern sandshell (<i>Hamiota (=Lampsilis) australis</i>)	The southern sandshell is typically found in small creeks and rivers in stable substrates of sand or mixtures of sand and fine gravel, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61672

Tapered pigtoe (<i>Fusconaia burkei</i>)	The tapered pigtoe is found in medium creeks to medium rivers in stable substrates of sand, small gravel, or sandy mud, with slow to moderate current (Williams et al. 2008, p. 296).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama PearlsheIl, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Final rule. Page 61670</u>
Tar River spinymussel (<i>Elliptio steinstansana</i>)	The preferred habitat of the Tar spinymussel appears to be relatively fast-flowing, well-oxygenated water, in sites with a substrate comprised of relatively silt-free, uncompacted gravel and coarse sand (USFWS 1992).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F015.html
Upland combshell (<i>Epioblasma metastrata</i>)	Restricted to shoals in rivers and large streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2000. <u>Recovery Plan for the Mobile River Basin (15 species). Page 61</u>
Yellow blossom (pearl)mussel (<i>Epioblasma florentina florentina</i>)	Riverine and typically found in streams which are shallow with sandy-gravel substrate with rapid currents (Stansbery, 1971)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1985. <u>Recovery plan for three mussels. Page 20.</u> http://ecos.fws.gov/docs/recovery_plan/850125.pdf
Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)	The only known locality at which the Alabama cavefish occurs is Key Cave in Lauderdale county, Alabama. Low temperature and periodic flooding are characteristic of the aquatic habitat in caves (USFWS 1990)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1990. <u>Alabama cavefish recovery plan. Page 2. Available online at:</u> http://ecos.fws.gov/docs/recovery_plan/901025.pdf

<u>Alabama sturgeon</u> (<i>Scaphirhynchus suttkusi</i>)	Very little is known of the habitat requirements of the Alabama Sturgeon. Based on capture data, it inhabits the main channel of large coastal plain rivers of the Mobile River Basin. Most specimens have been taken in moderate to swift current at depths of 6 to 14 m, over sand, gravel or mud bottom (Williams and Clemmer 1991). (USFWS 2013)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2013. <u>Recovery Plan for the Alabama Sturgeon</u> (<i>Scaphirhynchus suttkusi</i>). Page 13.
<u>Big Bend gambusia</u> (<i>Gambusia gaigei</i>)	The Big Bend gambusia is restricted to small, desert spring habitats. The spring ponds at Rio Grande Village that harbor the fish are clear warm water, stenothermal (constant temperature) springs. Hubbs (2001, pp. 315-316) documented the average outflow temperatures of Spring 4 and Spring 1 as 34.9 °C (95°F) and 33.1°C (92°F), respectively, with very low variability. The Big Bend gambusia is often found associated with dense stands of Chara spp. (submerged plant) and emergent vegetation in the refuge ponds (Hubbs et al. 2002, p. 82).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Big Bend gambusia - 5 year review</u> . Page 8.
<u>Cahaba shiner</u> (<i>Notropis cahabae</i>)	The habitat of the Cahaba shiner appears to be large shoal areas in the main channel of the Cahaba river (Howell et al. 1982). The species is found in the quieter waters, less	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1992. Cahaba shiner (<i>Notropis cahabae</i>) Recovery plan. Pages 1-3. Available at: http://ecos.fws.gov/docs/recovery_plan/920423.pdf

	<p>than 1.6 feet (0.5 meters) deep, just below swift riffle areas (Howell et al. 1982). The Cahaba shiner seems to prefer sandy patches in gravel beds or downstream of larger rocks and boulders. The species is generally found in relatively clear, well oxygenated water. It probably requires a river with sufficient small crustaceans, insect larvae, and algae for food, similar to its close relatives (Gilbert and Burgess 1980). (USFWS 1992)</p>		
<p><u>Cape Fear shiner (<i>Notropis mekistocholas</i>)</u></p>	<p>The Cape Fear shiner is generally associated with gravel, cobble, and boulder substrate, and it has been observed inhabiting slow pools, riffles, and slow runs often associated with water willow (<i>Justicia</i>) beds (Palmer and Braswell, North Carolina State Museum of Natural History, personal communication, 1986; Pottem and Huish 1985, 1986; Snelson 1971).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1988. Cape Fear shiner Recovery Plan. Page 1. Available at: http://ecos.fws.gov/docs/recovery_plan/060313.pdf</p>
<p><u>Cherokee darter (<i>Etheostoma scotti</i>)</u></p>	<p>Cherokee darters inhabit small to medium size warm-water creeks of moderate gradient with predominantly rocky bottoms. They are usually found in shallow water sections of reduced currents typically in areas above and below riffles and at the ecotones of riffles</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1994. <u>ETWP: Determination of Threatened Status for the Cherokee Darter and Endangered Status for the Etowah Darter</u>. Page 65506.</p>

	<p>and backwaters. Moreover, this species as associated with large gravel, cobble, and small boulder substrates, and is uncommonly, or rarely found over bedrock, fine gravel, or sand. It is most abundant in stream sections with relatively clear water and clean substrates (little Silt deposition). (USFWS 1994)</p> <p>The Cherokee darter is endemic to the Etowah River system in north Georgia where it is primarily restricted to streams draining the Piedmont physiographic province, and to a lesser extent, the Blue Ridge physiographic province. (USFWS 1994)</p>		
<p><u>Clear Creek gambusia</u> (<i>Gambusia heterochir</i>)</p>	<p>This species is restricted to the Clear Creek headspring pool that is characterized as clear, stenothermal, low pH (6.1 - 6.5) water with abundant aquatic vegetation composed mostly of an endemic, undescribed morph of <i>Ceratophyllum sp.</i></p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1982. <u>Recovery Plan for Clear Creek Gambusia</u>. Pages 2-3.</p> <p>Life Histories: Clear Creek Gambusia (<i>Gambusia heterochir</i>). http://ecos.fws.gov/docs/life_histories/E005.html</p>
<p><u>Comanche Springs pupfish</u> (<i>Cyprinodon elegans</i>)</p>	<p>The present habitat of the species consists mostly of a system of earthen and concrete irrigation canals. The water from Phantom Lake Spring is diverted into agricultural fields or sometimes flows down Phantom Lake Canal to merge with the</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1981. Recovery Plan for the Comanche Springs Pupfish. Page 2. Available at: http://ecos.fws.gov/docs/recovery_plan/051221a.pdf</p>

	flow from San Solomon Spring.		
<u>Devils River minnow</u> <i>(Dionda diaboli)</i>	<p>(1) Streams characterized by:</p> <p>a. Areas with slow to moderate water velocities between 10 and 40 cm/second (4 and 16 in/second) in shallow to moderate water depths between approximately 10 cm (4 in) and 1.5 m (4.9 ft), near vegetative structure, such as emergent or submerged vegetation or stream bank riparian vegetation that overhangs into the water column;</p> <p>b. Gravel and cobble substrates ranging in diameter between 2 and 10 cm (0.8 and 4 in) with low or moderate amounts of fine sediment (less than 65 percent stream bottom coverage) and low or moderate amounts of substrate embeddedness; and</p> <p>c. Pool, riffle, run, and backwater components free of artificial instream structures that would prevent movement of fish upstream or downstream.</p> <p>(2) High-quality water provided by permanent, natural flows from groundwater springs</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2008. Designation of Critical Habitat for the Devils River Minnow; Final rule. 73 FR 46988 47026. Page 47001. Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-08-12/pdf/E8-17985.pdf#page=1</p>

	<p>and seeps characterized by:</p> <ul style="list-style-type: none"> a. Temperature ranging between 17°C and 29°C; b. Dissolved oxygen levels greater than 5.0 mg/l; c. Neutral pH ranging between 7.0 and 8.2; d. Conductivity less than 0.7 mS/cm and salinity less than 1 ppt; e. Ammonia levels less than 0.4 mg/l; and f. No or minimal pollutant levels for copper, arsenic, mercury, and cadmium; human and animal waste products; pesticides; fertilizers; suspended sediments; and petroleum compounds and gasoline or diesel fuels. <p>(3) Abundant aquatic food base consisting of algae; attached to stream substrates; and other microorganisms associated with stream substrates.</p> <p>(4) Aquatic stream habitat either devoid of nonnative aquatic species (including fish, plants, and invertebrates) or in which such nonnative aquatic species are at levels that allow for healthy populations of Devils River minnows.</p> <p>(5) Areas within stream courses that may be periodically dewatered for short time periods,</p>		
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	during seasonal droughts, but otherwise serve as connective corridors between occupied or seasonally occupied areas through which the species moves when the area is wetted. (USFWS 2008)		
<u>Etowah darter</u> <u>(<i>Etheostoma etowahae</i>)</u>	The Etowah darter inhabits warm and cool, medium and large creeks or small rivers that are moderate or high gradient with rocky bottoms and relatively shallow riffles and large gravel, cobble, and small boulder substrates. (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	1994. USFWS ETWP; Determination of Threatened Status for the Cherokee Darter and Endangered Status for the Etowah Darter. Page 65506. Available at: http://ecos.fws.gov/docs/federal_register/fr2753.pdf
<u>Fountain darter</u> <u>(<i>Etheostoma fonticola</i>)</u>	The fountain darter requires: 1) undisturbed stream floor habitats (including runs, riffles, and pools), 2) a mix of submergent vegetation (algae, mosses, and vascular plants) in part for cover, 3) clear and clean water, 4) constant water temperatures within the natural and normal river gradients, and 5) most importantly, adequate springflows. In general, <i>E. fonticola</i> prefers vegetated stream-floor habitats with constant water temperature. Higher densities of the fish are found in mats of the filamentous green algae (<i>Rhizoclonium sp.</i>) and the moss <i>Riccia</i> . It is occasionally found in areas lacking vegetation. Fountain	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1996. San Marcos and Comal springs and associated aquatic ecosystems (revised) recovery plan. Page 33. Available at: http://ecos.fws.gov/docs/recovery_plan/960214.pdf

	darters have also been observed among leaf litter in the Comal River. (USFWS 1996)		
<u>Goldline darter</u> <u>(<i>Percina</i></u> <u><i>aurolineata</i>)</u>	Prefers a moderate to swift current and water depths greater than 2 feet (Howell et al. 1982). It is found over sand or gravel substrate interspersed among cobble and small boulders. (USFWS 1992)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	1992. USFWS ETWP; Threatened Status for Two Fish, the Goldline Darter (<i>Percina aurolineata</i>) and Blue Shiner (<i>Cyprinella caerulea</i>). Page 14786. http://ecos.fws.gov/docs/federal_register/fr2036.pdf
<u>Leon Springs pupfish</u> <u>(<i>Cyprinodon</i></u> <u><i>bovinus</i>)</u>	The Leon Springs pupfish inhabits highly saline habitat preferring quiet waters near the edge of shallow pools with a minimal growth of vegetation. (USFWS 1980)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	1980. USFWS ETWP; Listing of Leon Springs pupfish as endangered with critical habitat. Page 14786. http://ecos.fws.gov/docs/federal_register/fr457.pdf
<u>Palezone shiner</u> <u>(<i>Notropis</i></u> <u><i>albizonatus</i>)</u>	The palezone shiner occurs in flowing pools and runs of upland streams that have permanent flow, clear water, and substrates composed of bedrock, cobble, pebble, and gravel mixed with clean sand (USFWS 1997). In May 1990, Warren et al. (1994) collected the species in the PRR from pools (60-75 cm depth) over fine to coarse gravel mixed with sand. In June 1990, Warren et al. (1994) observed the species in shallow (30-45 cm, 1.2-1.8 in) runs and pools of the Little South Fork that were underlain by fractured bedrock and scattered gravel patches. In	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2014. Palezone shiner (<i>Notropis albizonatus</i>) 5-year review: summary and evaluation. US Fish and Wildlife Service Southeast Region Kentucky Ecological Services Field Office John C. Watts Federal Building 330 West Broadway, Room 265 Frankfort Kentucky, 40601. Page 8. http://ecos.fws.gov/docs/five_year_review/doc4374.pdf

	<p>August 1990, they collected individuals in the Little South Fork from pools and runs with current velocities ranging from 0.6-4.5 cm/sec (0.02-0.15 feet/sec) and mean depth of 59 cm (2.3 in). Substrates varied from sand mixed with fine and coarse gravel to bedrock. Shepard et al. (1997) reported the species from pools and runs of the PRR that had substrates composed of a mixture of cobble, gravel, and sand. Water depths ranged from 30.5-76.2 cm (12-30 in). (USFWS 2014)</p>		
<p><u>Pecos gambusia</u> (<i>Gambusia nobilis</i>)</p>	<p><i>Gambusia nobilis</i> occurs abundantly in springheads and spring runs. Moderately abundant populations are also known from areas with little spring influence, but with abundant overhead cover, sedge covered marshes, and gypsum sinkholes. <i>G. nobilis</i> has been observed to occur from the surface to depths of three meter.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS ECOS Life Histories for the Pecos gambusia (<i>Gambusia nobilis</i>)</p> <p>http://ecos.fws.gov/docs/life_histories/E00V.html</p>
<p><u>Pygmy Sculpin</u> (<i>Cottus paulus</i> (=pygmaeus))</p>	<p>Gravel and sand substrate. Habitat also contains large rocks where the spring boils occur.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>Life Histories: Pygmy sculpin (<i>Cottus paulus</i> (=pygmaeus)).</p> <p>http://ecos.fws.gov/docs/life_histories/E01L.html</p>
<p><u>Relict darter</u> (<i>Etheostoma chienense</i>)</p>	<p>Adults are concentrated in headwaters of streams in slow flowing pools (0.2-0.6 m/sec), usually over gravel mixed with sand and under or near cover</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>2013. US Fish and Wildlife Service Southeast Region, Relict darter (<i>Etheostoma chienense</i>) Five Year Review Summary and Evaluation, Page 8.</p>

	such as fallen tree branches, undercut banks, or overhanging riparian vegetation. (USFWS 2013)		https://ecos.fws.gov/docs/five_year_review/doc4178.pdf
<u>Rush Darter</u> <u>(<i>Etheostoma</i></u> <u><i>phytophilum</i>)</u>	Habitats tend to be shallow, clear, and cool, with moderate current and substrates composed of a combination of sand with silt, muck, gravel or bedrock. (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	Fish and Wildlife Service Department of the Interior, 2012, Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Cumberland darter, Rush darter, Yellowcheek darter, Chucky madtom, and Laurel dace, Volume 77 No. 200, Page 63605 http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>San Marcos gambusia</u> <u>(<i>Gambusia</i></u> <u><i>georgei</i>)</u>	The San Marcos gambusia apparently prefers quiet waters adjacent to sections of moving water, but seemingly of greatest importance, thermally constant waters. <i>G. georgei</i> is found mostly over muddy substrates but generally not silted habitats, and shade from over-hanging vegetation or bridge structures is a factor common to all sites along the upper San Marcos River where apparently suitable habitats for this species occur (Hubbs and Peden 1969, Edwards et. al. 1980).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1996. San Marcos and Comal springs and associated aquatic ecosystems (revised) recovery plan. Page 29. Available at: http://ecos.fws.gov/docs/recovery_plan/960214.pdf
<u>Sharpnose Shiner</u> <u>(<i>Notropis</i></u> <u><i>oxyrhynchus</i>)</u>	Sharpnose shiners occur in fairly shallow, flowing water, often less than 0.5 m (1.6 ft) deep with sandy substrates... minimum estimated reach length	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2014. Designation of Critical Habitat for Sharpnose Shiner and Smalleye Shiner; Final Rule. Page 45250.

	requirements for similar species and current modeling efforts for this species indicate an unobstructed reach length of greater than 275 km (171 mi) is likely required to complete the species' life history.		
<u>Shortnose sturgeon</u> <u>(<i>Acipenser brevirostrum</i>)</u>	Shortnose sturgeon are found in rivers, estuaries, and the sea, but populations are confined mostly to natal rivers and estuaries. The species appears to be estuarine anadromous in the southern part of its range, but in some northern rivers it is "freshwater amphidromous", i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life (Kieffer and Kynard 1993). Adults in southern rivers forage at the interface of fresh tidal water and saline estuaries and enter the upper reaches of rivers to spawn in early spring (Savannah River: Hall et al. 1991; Altamaha River: Heidt and Gilbert 1979; Flourenoy et al. 1992, Rogers and Weber 1995a; Ogeechee River: Weber 1996).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS 1998. Final Recovery Plan for the Shortnose Sturgeon (<i>Acipenser brevirostrum</i>). Page 25. Available at: http://ecos.fws.gov/docs/recovery_plan/sturgeon_shortnose_1.pdf

<u>Smalltooth sawfish (<i>Pristis pectinata</i>)</u>	Generally inhabit the shallow coastal waters of bays, banks, estuaries and river mouths, particularly shallow mud banks and mangrove habitats. Larger animals can be found in the same habitat, but are also found offshore at depths up to least 122 meters.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	National Marine Fisheries Service, 2009, Smalltooth sawfish Recovery Plan. Page v. http://ecos.fws.gov/docs/recovery_plan/smalltoothsawfish.pdf
<u>Sunfish, spring pygmy (<i>Elassoma alabamae</i>)</u>	Clear to slightly stained spring water, occurring within spring heads (where cool water emerges from the ground), spring pools (water pool at spring head), spring runs (stream or channel downstream of spring pool), and associated spring-fed wetlands... occupying depths from 13 to 102 cm (in water column)... prefers patches of dense filamentous submergent vegetation	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	Endangered and Threatened Wildlife and Plants; Threatened Species Status for Spring Pygmy Sunfish, Federal Register, 2013, 78(191): 60766-60783. Page 60768. http://www.gpo.gov/fdsys/pkg/FR-2013-10-02/pdf/2013-23726.pdf
<u>Vermilion darter (<i>Etheostoma chermocki</i>)</u>	Small to medium-sized clear streams, with gravel riffles and moderate currents (Kuehne and Barbour, 1983; Etnier and Starnes, 1993). Boschung et al. (1992) described the stream habitat for vermilion darters as 3 to 20 m wide, 0.01 to more than 0.5 m in depth, with pools of moderate current alternating with riffles of moderately swift current, and low water turbidity. Blanco and Mayden (1999) found this species	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	Daniel J Drennen and the Vermilion Darter Recovery Team / US Fish and Wildlife Service Department of Interior, 2007, Recovery Plan Vermilion Darter, Page 11 http://ecos.fws.gov/docs/recovery_plan/070802.pdf

	primarily in areas dominated by fine gravel with some coarse gravel or cobble. This species is absent in habitats with only a bedrock bottom, but has been found on bedrock with sand and gravel... This species is generally not found in deeper pool habitats.		
<u>Waccamaw silverside</u> (<i>Menidia extensa</i>)	The species is usually found in schools near the surface. It forages in areas of shallow, open water over a clean, dark sand substrate with no vegetation and spawn in open-water areas near the shoreline.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS Life histories document. http://ecos.fws.gov/docs/life_histories/E01P.html
<u>Watercress darter</u> (<i>Etheostoma nuchale</i>)	Prefer deeper, slow moving backwater areas of springs that are choked with aquatic vegetation such as watercress (<i>Nasturtium</i>), and algae (<i>Chara</i> and <i>Spirogyra</i>).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS Life Histories Watercress darter (<i>Etheostoma nuchale</i>) http://ecos.fws.gov/docs/life_histories/E00U.html

Species	Habitat	Rationale	Source
Plants			
<u>Avens spreading</u> (<i>Geum radiatum</i>)	This species grows in full sun on the shallow acidic soils of high-elevation cliffs, rocky outcrops, steep slopes, and on gravelly talus (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with high-elevation cliffs, rocky outcrops, steep slopes or gravelly talus.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930428.pdf
<u>Bluet. Roan Mountain</u> (<i>Hedysotis purpurea</i> var. <i>montana</i>)	This species grows in shallow soils and crevices of cliffs and outcrops and on thin rocky soils of grassy balds (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with cliffs and outcrops.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960513.pdf

Species	Habitat	Rationale	Source
<u>Chaffseed</u> <u>American</u> <u>(Schwalbea</u> <u>americana)</u>	Habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with pine flatwoods, fire-maintained savannas, wetland or sedge dominated systems.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950929c.pdf
<u>Clover, running</u> <u>buffalo</u> <u>(Trifolium</u> <u>stoloniferum)</u>	Running buffalo clover occurs in mesic habitats of partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).	The proposed dicamba DGA uses are not expected to overlap with mesic habitats where the clover is expected to be found.	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

Species	Habitat	Rationale	Source
<u>Daisy, Lakeside</u> <u>(<i>Hymenoxys</i></u> <u><i>herbacea</i>)</u>	Although historical habitats include outcrops of dolomite or limestone bedrock, dry, gravelly prairies on terraces or hills associated with major river systems, rocky shores, sandy fields and alvars, the Lakeside daisy in the U. S. is now restricted to dry, thin-soiled, degraded prairies in which limestone or dolomite bedrock is at or near the surface. Habitats are alkaline, seasonally wet in spring and fall, and are moderately to extremely droughty in summer. Typically, habitats have little topographic relief, are relatively open at the ground surface, and vegetation density and diversity are relatively low. Within these habitats, lakeside daisy occurs in open patches of ground, occupies the dry to mesic portions of the soil moisture continuum and has a highly aggregated distribution. This species is either absent or infrequently found in shaded or densely vegetated areas (US FWS, 1990, pp. 20-21).	The proposed dicamba DGA uses are not expected to overlap with quarries and dry prairies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf
<u>Fern, American</u> <u>hart's-tongue</u> <u>(<i>Asplenium</i></u> <u><i>scolopendrium</i></u> <u>var.</u> <u><i>americanum</i>)</u>	Early successional habitats Northern populations occur in forests of secondary growth where canopy openings are abundant. New York populations	The proposed dicamba DGA uses are not expected to overlap early successional forests, conifer forests or bryophyte beds where the species is found.	http://ecos.fws.gov/docs/recovery_plan/930915.pdf

Species	Habitat	Rationale	Source
	occur in conifer forests. Bryophyte beds are an important substrate.		
Fleshy-fruit gladeceess (<i>Leavenworthia crassa</i>) ²	PCEs: (1) Shallow-soiled, open areas with exposed limestone bedrock or gravel that are dominated by herbaceous vegetation characteristic of glade communities. (2) Open or well-lighted areas of exposed limestone bedrock or gravel that ensure fleshy-fruit gladeceess plants remain unshaded for a significant portion of the day. (3) Glade habitat that is protected from both native and invasive, nonnative plants to minimize competition and shading of fleshy-fruit gladeceess.	Technical consultation with USFWS biologist indicated that this species will not persist in soy or cotton fields due to the competing vegetation.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q12K#crittab http://www.gpo.gov/fdsys/pkg/FR-2014-08-26/pdf/2014-19558.pdf <u>Email communication (Holbrook, S. (2015, June 17).</u>
<u><i>Geocarpon minimum</i> (No common name)</u>	This species grows on sandstone glades and outcrops as well as bare, sparsely vegetated areas where the soil contains relatively large amounts of magnesium and sodium salts (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with the sandstone glades and outcrops where this species is expected to be found.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930726.pdf
<u>Goldenrod, Blue Ridge (<i>Solidago spithamea</i>)</u>	This species grows on rock outcrops and vertical to near vertical cliffs in southern Appalachians of western North Carolina and extreme eastern TN. Rocky summits and cliffs usually appear as smaller-scale patchy habitats embedded in larger	The proposed dicamba DGA uses are not expected to overlap with rock outcrops and vertical cliffs.	USFWS. 1987. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/blueridge%20goldenrod%20rp.pdf

² Bold text indicates the four species with effects determination “may affect, likely to adversely affect”.

Species	Habitat	Rationale	Source
	forest consisting of spruce-fir or northern hardwoods or occasionally high elevation red oak forest (US FWS, 1987).		
<u>Grass, Tennessee yellow-eyed (Xyris tennesseensis)</u>	<i>Xyris tennesseensis</i> is a rare perennial monocot that is an obligate wetland plant that prefers relatively high pH seeps and streambanks. An Obligate wetland plant that is restricted to calcareous seeps, fens, and spring runs (US FWS, 2014).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2014. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4360.pdf
<u>Harperella (Ptilimnium nodosum)</u>	Harperella is known from only two locations in North Carolina. One population occurs in the Tar River in Granville County. Another population was reintroduced to the Deep River recently after the original population known from that area disappeared. This population occurs in Chatham County, but the river serves as the divide between Chatham and Lee counties (US FWS, 1991).	The proposed dicamba DGA uses are not expected to overlap with river habitats.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910305b.pdf
<u>Iris, dwarf lake (Iris lacustris)</u>	The dwarf lake iris grows along the northern shorelines of lakes Michigan and Huron in Wisconsin, Michigan and Ontario, Canada. It typically occurs in shallow soil over moist calcareous sands, gravel and beach rubble. Sunlight is one	The proposed dicamba DGA uses are not expected to overlap with shoreline coniferous forests.	USFWS. 2013. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/DLI%20RP%20FINAL%20AUG2013_1.pdf

Species	Habitat	Rationale	Source
	of the most critical factors to the growth and reproduction of the species and partly shaded or sheltered forest edges are optimal for sexual reproduction. Some form of disturbance is also required to maintain the forest openings that provide these partial shade conditions. The species is most often associated with shoreline coniferous forests dominated by northern white cedar and balsam fir. The principal limiting factor for dwarf lake iris is the availability of this suitable shoreline habitat (US FWS, 2013, pp. 6-7).		
<u>Lichen, rock gnome</u> <u>(<i>Gymnoderma lineare</i>)</u>	<p>Rock gnome lichen is primarily limited to vertical rock faces where seepage water from forest soils above flows during (and only during) very wet times. It appears the species needs a moderate amount of light, but that it cannot tolerate high-intensity solar radiation. It does well on moist, generally open, sites, with northern exposures, but needs at least partial canopy coverage where the aspect is southern or western</p> <p>Rock gnome lichen is known from the Southern Appalachian</p>	The proposed dicamba DGA uses are not expected to overlap with high elevation vertical rock faces where the species occurs.	http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html

Species	Habitat	Rationale	Source
	Mountains of North Carolina and South Carolina, Tennessee, and Georgia, in areas of high humidity, either at high elevations, where it is frequently bathed in fog, or in deep gorges at lower elevations.		
Lyrate bladderpod (<i>Lesquerella lyrata</i>)	Limestone glades	Technical consultation with USFWS biologist indicated that this species will not occur in corn, soy, or cotton fields within the range	http://ecos.fws.gov/docs/recovery_plan/961017.pdf Email communication (Holbrook, S. (2015, June 17)).
Orchid, eastern prairie fringed (<i>Platanthera leucophaea</i>)	The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	The proposed dicamba DGA uses are not expected to overlap with grass or sedge-dominated plant communities.	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf

Species	Habitat	Rationale	Source
<u>Pogonia, small whorled (<i>Isotria medeoloides</i>)</u>	The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).	The proposed dicamba DGA uses are not expected to overlap with mixed deciduous/coniferous forests.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf
<u>Pondberry (<i>Lindera melissifolia</i>)</u>	Associated with seasonally flooded wetlands. Found on wet edges of sandy sinks, ponds, and swampy depressions. Shade tolerant (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930923a.pdf

Species	Habitat	Rationale	Source
<u>Potato-bean, Price's (<i>Apios priceana</i>)</u>	Found in open forests along the edges of forests, creeks, and rivers (US FWS, 1993, p. executive summary).	The proposed dicamba DGA uses are not expected to overlap with forests, or water bodies.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930210.pdf
<u>Prairie-clover, leafy (<i>Dalea foliosa</i>)</u>	Leafy prairie-clover is found only in open limestone cedar glades, limestone barrens, and dolomite prairies which have shallow, silt to silty clay loam soils over flat and often highly fractured, horizontally bedded limestone or dolomite with frequent expanses of exposed bedrock at surface. Elevations are typically between 550 and 700 feet. These habitats experience high surface and soil temperatures, generally have low soil moisture but are wet in the spring and fall and become droughty in summer. The distribution of glade, barren, and dry to wet dolomite prairie at any particular site varies and leads to a mosaic of soils and their associated plant communities (USFWS, 1996, p.13).	The proposed dicamba DGA uses are not expected to overlap with prairies or areas with visible bedrock.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf
<u>Quillwort, Louisiana (<i>Isoetes louisianensis</i>)</u>	This species grows in sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland. bayhead forests of fine flatwoods and upland longleaf pine (USFWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with streams, overflow channels, or riparian woodlands.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930b.pdf

Species	Habitat	Rationale	Source
<u>Rock-cress</u> <u>Braun's (<i>Arabis</i></u> <u><i>perstellata</i>)</u>	Braun's rockcress occurs on the slopes of calcareous mesophytic and sub-xeric forest types. The occurrence of this species does not appear to be limited to a particular slope aspect, elevation, or moisture regime within the slope forests. It is, however, sun intolerant and always occurs in at least partial shade. The largest and most vigorous populations occur on moist mid- to upper slope sites. Plants are often found around rock outcrops, protected sites on the downslope side of tree bases, and sites of natural disturbance, such as talus slopes and animal trails. It is rarely found growing among the Leaf litter and herbaceous cover of the forest floor (US FWS, 1997).	The proposed dicamba DGA uses are not expected to overlap with calcareous mesophytic and sub-xeric forested systems.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970722.pdf
<u>Rosemary</u> <u>Cumberland</u> <u>(<i>Conradina</i></u> <u><i>verticillata</i>)</u>	This species is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to	The proposed dicamba DGA uses are not expected to overlap with rivers.	USFWS. 2011. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3629.pdf

Species	Habitat	Rationale	Source
	maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (pg. 8) (US FWS, 2011).		
<u>Sandwort, Cumberland</u> (<u>Arenaria cumberlandensis</u>)	This species is restricted to sandstone rock houses, ledges, and solution pockets on sandstone rock faces; The species is found on the sandy floors of rock houses, in solution pockets on the face of sandstone cliffs, and on ledges beneath overhanging sandstone (pg. 4) (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with sandstone rock houses, ledges, or rock faces.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960620.pdf
<u>Skullcap, large-flowered</u> (<u>Scutellaria montana</u>)	This species occurs in slope, ravine, and stream-bottom forests in northwestern Georgia and adjacent southeastern Tennessee. Habitat loss and lack of information on appropriate management are the factors limiting the number of viable populations (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with ravine and stream-bottom forests.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960515.pdf
<u>Spiraea, Virginia</u> (<u>Spiraea virginiana</u>)	<i>Spiraea virginiana</i> is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf

Species	Habitat	Rationale	Source
	near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-18.).		
<u>Sunflower, whorled</u> (<u>Helianthus verticillatus</u>)	This species occurs in remnant prairie habitats found in uplands and swales of headwater streams in the Coosa River watershed in Georgia and Alabama and in the East Fork Forked Deer and Tuscumbia Rivers' watersheds in Tennessee. (US FWS 2014, p. 50993)	The proposed dicamba DGA uses are not expected to overlap with prairie habitats.	USFWS. 2014. Federal Register: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2014-08-26/pdf/2014-19558.pdf
<u>Thistle, Pitcher's</u> (<u>Cirsium pitcheri</u>)	It occurs on non-forested sand dunes of several types (grassland dunes, simple linear beach foredunes, continuous and discontinuous dune complexes), sand beaches, and sandy blowouts, primarily occurring around the Great Lakes (US FWS, 2002, p. 23-27).	The proposed dicamba DGA uses are not expected to overlap with sand dunes, sand beaches, or sandy blowouts.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920b.pdf
<u>Alabama canebrake pitcher-plant</u> (<u>Sarracenia rubra alabamensis</u>)	Occurs in sandhill seeps, swamps, and bogs along the fall-line of central Alabama. Colony sites are wet much of the year and are often characterized as wet bogs or wet	The proposed dicamba DGA uses are not expected to overlap with seeps, swamps or bogs.	1992 USFWS Recovery Plan: Alabama Canebrake Pitcher Plant 2012 USFWS Alabama Canebrake Pitcher-Plant (<i>Sarracenia rubra</i> ssp. <i>alabamensis</i>)

Species	Habitat	Rationale	Source
	flatwoods. Within this general habitat type, colony health seems to be a function of unaltered hydrology and maintenance of an early successional stage in which competing woody vegetation is limited. Naturally occurring fires and hydrological conditions control the pioneering of woody species on these sites (USFWS 1992)		5-Year Review: Summary and Evaluation
<u>Alabama leather flower</u> (<i>Clematis socialis</i>)	Occurs in mesic flats, specifically in right-of-ways, bush-hogged areas, forests that have been selectively logged (USFWS 1989) Open grass-seed-rush prairie areas and adjoining hardwood swamp forests (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with mesic flats or forests.	1989 USFWS Alabama leather flower recovery plan 2010 USFWS Alabama leather flower 5-year review
<u>Alabama streak-sorus fern</u> (<i>Thelypteris pilosa</i> var. <i>alabamensis</i>)	All known Alabama occurrences of the Alabama streak-sorus fern are found on Pottsville sandstone, where plants grow in crevices and rough surfaces on the roofs and floors of sandstone rockhouses formed along these cliffs (Watkins and Farrar 2002). The plants typically occur on moist, shady sites such as ceilings of rockhouses, ledges beneath sandstone overhangs, and on exposed cliff faces	The proposed dicamba DGA uses are not expected to overlap with sandstone rockhouses.	2014 USFWS Alabama streak-sorus fern (<i>Thelypteris burksiorum</i>) 5-year Review: Summary and Evaluation. Page 7. Available at: http://ecos.fws.gov/docs/five_year_review/doc4363.pdf

Species	Habitat	Rationale	Source
	(USFWS 1996). Locations vary in slope aspect and shade coverage, from completely shaded to partially sunny on exposed bluff faces. Sites are usually directly above or a short distance from the river, are shaded to partially sunny, and have substrates that are kept moist by water vapor from the river and up-slope runoff over the sandstone (USFWS 1996). (USFWS 2014)		
<u>Ashy dogweed</u> <u>(<i>Thymophylla</i></u> <u><i>tephroleuca</i>)</u>	Occurs in the ceniza-blackbrush-creosotebush brush community in the South Texas Plains vegetation area; however, this site may have originally been grassland. Noted to grow in open areas on fine-sandy loam, however the only known population occurs on Maverick-Caterina soil association, which is clayey, saline, deep to shallow, fine textured, and slowly permeable. Underlying geology is the Laredo Formation, composed of Eocene sandstones and clays. The habitat probably once supported a greater diversity of plants, but dominant plants now are buffelgrass (<i>Cenchrus ciliaris</i>), mequite (<i>Prosopis glandulosa</i>), goatbush (<i>Castela</i>	The proposed dicamba DGA uses are not expected to overlap with plains.	1987 USFWS Ashy Dogweed (<i>Thymophylla tephroleuca</i>) Recovery Plan

Species	Habitat	Rationale	Source
	<i>texana</i>), Cenizo (<i>Leucophyllum frutescens</i>), anacahuita (<i>Cordia boissieri</i>), yucca (<i>yucca spp</i>), and javelina brush (<i>Microrhamnus ericoides</i>) (USFWS 1987)		
<u>Black lace cactus</u> (<i>Echinocereus reichenbachii</i> var. <i>albertii</i>)	This species is found in the vicinity of dense brush, but grows in mostly open, unshaded areas (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with areas of dense brush.	2009 USFWS Black Lace Cactus (<i>Echinocereus reichenbachii</i> var. <i>albertii</i>) 5-year Review: Summary and Evaluation
<u>Black spored quillwort</u> (<i>Isoetes melanospora</i>)	Black-spored quillwort is restricted to shallow, flat bottomed depressions on granitic outcrops in the piedmont region of Georgia. Depressions are entirely rock rimmed and generally occur near the summit, with most water accumulating from direct rainfall and little flowing water to provide nutrient input. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2008 USFWS Granite Outcrop Plants 5-year Review. Page 8. Available at: http://ecos.fws.gov/docs/five_year_review/doc1987.pdf
<u>Bunched arrowhead</u> (<i>Sagittaria fasciculata</i>)	Obligate wetland species. Saturated to flooded soils. Undisturbed sites are typically located just below the origin of slow, continuous seeps on gently sloping terrain in deciduous woodlands (USFWS 1983)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1983 USFWS Bunched Arrowhead Recovery Plan.
<u>Bunched cory cactus</u> (<i>Coryphantha ramillosa</i>)	The species grows on limestone in xerophyllous scrub and in the desert on bare rock, talus, or scree. <i>Coryphantha ramillosa</i> also grows in	The proposed dicamba DGA uses are not expected to overlap with desert.	1989 USFWS Bunched Cory Cactus (<i>Cory Dhantha ramillosa</i>) Recovery Plan

Species	Habitat	Rationale	Source
	Chihuahuan Desert succulent scrub on rocky slopes, ledges, and gravelly flats on Santa Elena or Boquillas limestones (USFWS 1989)		
<u>Canby's dropwort</u> (<i>Oxypolis canbyi</i>)	Coastal plains - specifically in pond cypress savannas, the shallows and edges of cypress pond/pine sloughs, and wet pine savannas. These are shallowly flooded, open habitats. Found in natural ponds dominated by cypress, grass-sedge dominated Carolina bays. (USFWS 1990) Wetlands (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1990 USFWS Canby's dropwort recovery plan 2010 USFWS Canby's dropwort 5-year review
<u>Chisos Mountain hedgehog Cactus</u> (<i>Echinocereus chisoensis</i> var. <i>chisoensis</i>)	Alluvial flats with Chihuahuan desert scrub vegetation (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with deserts.	1993 USFWS Chisos Mountain hedgehog cactus recovery plan
<u>Cooley's meadowrue</u> (<i>Thalictrum cooleyi</i>)	Grassland/herbaceous, woody wetland, and herbaceous wetlands (p. i). (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1994 USFWS Recovery Plan
<u>Davis' green pitaya</u> (<i>Echinocereus viridiflorus</i> var. <i>davisii</i>)	Chihuahuan desert in a semi-arid grassland. (USFWS 1984) Outcrops of Caballos Novaculite Formation; found in cracks and crevices. (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with desert.	1984 USFWS 5-Year Reviews of 23 Southwestern Species 2012 USFWS Davis' green pitaya and Nellie's cory cactus 5-year review

Species	Habitat	Rationale	Source
<u>Dwarf-flowered heartleaf</u> (<i>Hexastylis naniflora</i>)	Along bluffs and north-facing slopes, boggy areas along streams, and adjacent hillsides and ravines with acid, sandy loam soils in deciduous forests	The proposed dicamba DGA uses are not expected to overlap with wetlands or bluffs.	USFWS NC State Herbarium Fact Sheet - Dwarf-flowered heartleaf
<u>Florida torreyia</u> (<i>Torreya taxifolia</i>)	The Florida torreyia is a dioecious coniferous tree found in the slope forest (FNAI 2010) that cover hammocks, steep, deeply shaded limestone slopes and wooded ravines along the east side of the Apalachicola River in Florida (Fig. 1), and adjacent Lake Seminole in Georgia. Soils in these areas are within the orders Alfisols and Mollisols. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with forests.	USFWS 2010. <i>Torreya taxifolia</i> (Florida torreyia) 5-Year Review. Page 13. Available at: http://ecos.fws.gov/docs/five_year_review/doc3258.pdf
<u>Fringed campion</u> (<i>Silene polypetala</i>)	Occurs in hardwood forests in bottomland and ravines. It is often on fairly steep slopes of deep ravines or north-facing hillsides, sometimes on nearly level ground, particularly in flatwoods developed on Iredell soils. Occurs mainly in small isolated patches of rich hardwood. The great majority of populations occur in the watershed of the Apalachicola River and its tributary, the Flint River. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with forests.	1996 USFWS Technical Agency Draft Recovery Plan for Fringed Campion (<i>Salene polypetula</i>) USFWS Species Profile: Fringed campion (<i>Silene polypetala</i>) (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q21P)

Species	Habitat	Rationale	Source
<u>Gentian pinkroot</u> (<i>Spigelia gentianoides</i>)	Well drained upland pinelands; longleaf pine-wiregrass ecosystem (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with forests.	2012 US FWS Gentian pinkroot 5-Year Review
<u>Golden sedge</u> (<i>Carex lutea</i>)	The land surface is characterized by large areas of broad, level flatlands and shallow stream basins. Golden sedge grows in sandy soils overlying coquina limestone deposits, where the soil pH is unusually high for this region, typically between 5.5 and 7.2. Soils supporting the species are very wet to periodically shallowly inundated. The species prefers the ecotone (narrow transition zone between two diverse ecological communities) between the pine savanna and adjacent wet hardwood or hardwood/conifer forest. Most plants occur in the partially shaded savanna/swamp where occasional to frequent fires favor an herbaceous ground layer and suppress shrub dominance. Other species with which this sedge grows include tulip poplar (<i>Liriodendron tulipifera</i>), pond cypress (<i>Taxodium ascendens</i>), red maple (<i>Acer rubrum</i> var. <i>trilobum</i>), wax myrtle (<i>Myrica cerifera</i> var. <i>axillaris</i>).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2009 USFWS Golden Sedge (<i>Carex lutea</i>) Five-Year Review: Summary and Evaluation

Species	Habitat	Rationale	Source
	<p><i>cerifera</i>), colic root (<i>Aletris farinosa</i>), and several species of beakrush (<i>Rhynchospora spp.</i>).</p> <p>At most sites, golden sedge shares its habitat with Cooley's meadowrue (<i>Thalictrum cooleyi</i>), another federally endangered plant species, and with Thorne's beakrush (<i>Rhynchospora thornei</i>), a species of concern to us. (USFWS 2009)</p>		
<p><u>Bat, gray</u> (<u>Myotis</u> <u>grisescens</u>)</p>	<p>Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when</p>	<p>The proposed dicamba DGA uses are not expected to encompass caves or the forest/open water areas where bats forage.</p>	<p>USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf</p> <p>USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf</p>

Species	Habitat	Rationale	Source
	migrating (US FWS, 1982. pp. 6-7).		
<u>Green pitcher-plant</u> <u>(<i>Sarracenia oreophila</i>)</u>	Habitats can be generally grouped into two types: stream banks (considered ephemeral) and upland bogs. Upland bogs, fire dependent, range from open to forested, underlain by semi-impervious clay layers (USFWS 2013)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2013 US FWS Green pitcher plant (<i>Sarracenia oreophila</i>) 5-Year Review: Summary and Evaluation
<u>Hairy rattleweed</u> <u>(<i>Baptisia arachnifera</i>)</u>	22 extant populations occur entirely in Lower Coastal Plain of Georgia, 125 square miles over northern Brantley County and southeastern corner of Wayne County. Longleaf slash-pine flatwoods with sparse canopy, fewer larger shrubs, greater light penetration and greater cover of herbs (mainly wiregrass) and low shrubs of the Lower Coastal Plain of Georgia. Early successional characteristics of open canopy and low abundance of larger shrubs. Mesic pine lowland forest or pine flatwoods. Also occurs in floristically similar but more open pine-wire grass (<i>Aristida stricta</i>) shrub woodlands with occasional oaks	The proposed dicamba DGA uses are not expected to overlap with the margins of cultivated land.	2011 USFWS Hairy Rattleweed (<i>Baptisia arachnifera</i>) 5-Year Review: Summary and Evaluation 1984 USFWS Recovery Plan for Hairy Rattleweed (<i>Baptisia arachnifera</i>)

Species	Habitat	Rationale	Source
	<p>(<i>Quercus laevis</i>, <i>Q. virginiana</i>, <i>Q. nigra</i>). Fire adapted communities that would naturally burn every 2-4 years. Most abundant in communities with the early successional characteristics of open canopy and low abundance of larger shrubs. Presently occurs in slash-pine plantations within its range, also along highway/utility/logging road ROWs and some natural communities (longleaf pine-wiregrass-shrub communities), and margins of cultivated land (generally corn, tobacco, and pasture). Level to gently sloping land. Often adjacent to/grades into pocosin or bay swamp habitats scrub-shrub wetlands toward the wetter end of spectrum to habitats typical of longleaf pine-turkey oak communities towards the drier end. (USFWS 2011)</p>		
<u>Heller's blazingstar</u> (<i>Liatris helleri</i>)	Heller's blazing star habitat consists of rock outcrops, ledges, cliffs, and balds at high elevations (USFWS 1989)	The proposed dicamba DGA uses are not expected to overlap with rock outcrops or cliffs.	1989 USFWS Recovery Plan for <i>Liatris helleri</i> (Heller's Blazing Star)
<u>Hinckley oak</u> (<i>Quercus hinckleyi</i>)	<i>Quercus hinckleyi</i> occurs in an arid subtropical climate. Climatologists place it in the Trans-Pecos climatic area of Texas, which is extremely	The proposed dicamba DGA uses are not expected to overlap with forests.	1991 USFWS Hinckley Oak (<i>Quercus hinckleyi</i>) 5-Year Review: Summary and Evaluation

Species	Habitat	Rationale	Source
	variable because of topographic differences. The area generally has great daily temperature fluctuations and an arid profile where evaporation exceeds precipitation. The average temperature is approximately 30.40°C (86.80°F), with an average precipitation of 23.4 cm (9.2 inches) (USFWS 1991)		
<u>Houghton's goldenrod</u> (<i>Solidago houghtonii</i>)	This plant grows on the shores of the Great Lakes, mainly Lake Huron and Lake Michigan, at the Michigan-Ontario border. (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with shores.	2011 US FWS Houghton's Goldenrod (<i>Solidago houghtonii</i> A. Gray, Asteraceae) 5-Year Review: Summary and Evaluation
<u>Johnston's frankenia</u> (<i>Frankenia johnstonii</i>)	Open or sparsely vegetated rocky gypsum hillsides or saline flats. In Texas, occur in mesquite blackbrush community (USFWS 1988)	The proposed dicamba DGA uses are not expected to overlap with saline flats.	1988 USFWS Johnston's Frankenia (<i>Frankenia johnstonii</i>) Recovery Plan 2003 USFWS Endangered and Threatened Wildlife and Plants; Delisting the plant Frankenia johnstonii (<i>Johnston's frankenia</i>) and Notice of Petition Finding.68 FR 27961
<u>Kentucky glade cress</u> (<i>Leavenworthia exigua laciniata</i>)	<i>Leavenworthia exigua</i> var. <i>laciniata</i> is typically found in cedar or limestone glades (Baskin and Baskin 1981, p. 243), which are described by Baskin and Baskin (1999, p. 206) as “open areas of rock pavement, gravel, flagstone, and/or shallow soil in which occur natural, long-persisting (edaphic climax) plant	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2014. Designation of Critical Habitat for <i>Leavenworthia exigua</i> var. <i>laciniata</i> (Kentucky Glade Cress); Final rule. Page 25691. Available at: http://www.gpo.gov/fdsys/pkg/FR-2014-05-06/pdf/2014-10050.pdf

Species	Habitat	Rationale	Source
	<p>communities dominated by angiosperms and/or cryptogams.”</p> <p><i>L. exigua</i> var. <i>laciniata</i> is also known from gladelike areas such as overgrazed pastures, eroded shallow soil areas with exposed bedrock, and areas where the soil has been scraped off the underlying bedrock (Evans and Hannan 1990, p. 8). These disturbed areas are gladelike in the shallowness or near-absence of their soils, saturation, and/or inundation during the wet periods of late fall, winter, and early spring and then frequently dry below the permanent wilting point during the summer (Baskin and Baskin 2003, p. 101). (USFWS 2014, p25691)</p>		
<u>Kral's water-plantain</u> <u>(<i>Sagittaria secundifolia</i>)</u>	<p>This taxon typically occurs on frequently exposed shoals or rooted among loose boulders in quiet pools up to 1 meter (3.3 feet) in depth. The plant is found in the Little River drainage in Dekalb and Cherokee counties, the Town Creek drainage in Dekalb County, and in the West Sipsey Fork in Winston County in Alabama. (USFWS 1991)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with water bodies.</p>	<p>1991 USFWS Kral's Water-Plantain (<i>Sagittaria secundifolia</i>) Recovery Plan</p>

Species	Habitat	Rationale	Source
<u>Large-fruited sand-verbena</u> (<i>Abronia macrocarpa</i>)	Post oak savanna region of eastern Texas. Documented wild populations occur in acid, relatively infertile sandy soils of the Arenosa, Silstead-Padina, Pickton, and Wolfpen series lie 79-127 cm deep over sandy clay loam. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with post oak savanna.	2010 USFWS 5-year review Large-fruited Sand-verbena (<i>Abronia macrocarpa galloway</i>)
<u>Little Aguja (=Creek) Pondweed</u> (<i>Potamogeton clystocarpus</i>)	Grows in alluvial substrates of shallow, protected area of Little Aguja Creek. Species located in pools along the streambed. Flash floods and drought are part of the normal stream ecology (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with alluvial areas around creeks.	1994 USFWS Little Aguja pondweed recovery plan (<i>Potamogeton clystocarpus</i>).
<u>Little amphianthus</u> (<i>Amphianthus pusillus</i>)	On granitic outcrops in the Piedmont physiographic region of the southeastern United States generally in eroded depressions or, rarely, quarry pools fanned on flat- to doming granite outcrops. Occur in shallow flat-bottomed pools on the crest or flattened slopes of unquarried outcrops. Pools might be several meters in diameter. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with granitic outcrops.	2008 USFWS Granite Outcrop Plants 5-year Review
<u>Lloyd's Mariposa cactus</u> (<i>Echinomastus mariposensis</i>)	Hills and lower slopes of mesas. Occur in full sun on patches of limestone chips. Chihuahuan desert scrub community. (USFWS 1990)	The proposed dicamba DGA uses are not expected to overlap with desert.	1990 USFWS Lloyd's Mariposa Cactus (<i>Neolloydia mariposensis</i>) Recovery Plan U.S. Fish and Wildlife Service Albuquerque, New Mexico

Species	Habitat	Rationale	Source
<u>Mat-forming quillwort</u> (<i>Isoetes tegetiformans</i>)	Mat-forming quillwort is restricted to shallow, flat bottomed depressions on granitic outcrops in the piedmont region of Georgia. Depressions are entirely rock rimmed and generally occur near the summit, with most water accumulating from direct rainfall and little flowing water to provide nutrient input. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with depressions on granitic outcrops.	2008 USFWS Granite Outcrop Plants 5-year Review. Page 8. Available at: http://ecos.fws.gov/docs/five_year_review/doc1987.pdf
<u>Miccosukee gooseberry</u> (<i>Ribes echinellum</i>)	Mixed mesophytic hardwoods (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with forests.	2008 US FWS Miccosukee Gooseberry 5-Year Review
<u>Michaux's sumac</u> (<i>Rhus michauxii</i>)	It is endemic to the inner coastal plain and piedmont of the Carolinas, Georgia, and Florida, where it occupies sandy or rocky open woods. It appears to depend upon some form of disturbance to maintain the open quality of its habitat. (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with sandy or rocky open woods.	1993 USFWS RECOVERY PLAN for Michaux's Sumac (<i>Rhus michauxii</i>) Sargent
<u>Michigan monkey-flower</u> (<i>Mimulus michiganensis</i>)	Aquatic to semi-aquatic habitat. It is restricted to cold, alkaline spring seepages and streams, usually in association with northern white cedar (<i>Thuja occidentalis</i>) swamps formed in drainages found at the base of relatively steep, morainic slopes and bluff. Within its habitat, it generally flourishes	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2011 USFWS Michigan Monkey-flower (<i>Mimulus michiganensis</i>) 5-Year Review: Summary and Evaluation 1997 USFWS Recovery Plan for Michigan Monkey-flower (<i>Mimulus glabratus</i> var. <i>michiganensis</i>)

Species	Habitat	Rationale	Source
	<p>best in tree canopy openings, along forest edges, or along streams adjacent to open, meadow-like areas and flowers abundantly when growing in full sunlight. However, it mostly persists as sterile colonies when growing under heavy tree canopy cover. (USFWS 2011)</p> <p>Surveys of some locations found water temperature ranging from 8.7 to 16.6° C, pH ranging from 7.66-8.4, conductivity ranging from 190 to more than 300 umhos and high concentrations of ammonium, nitrate, and phosphorus. (USFWS 1997)</p>		
<u>Mohr's Barbara button</u> <i>(Marshallia mohrii)</i>	<i>Marshallia mohrii</i> typically occurs in moist, prairie-like openings in woodlands and along shale-bedded streams. (USFWS 1991)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1991 USFWS RECOVERY PLAN for Mohr's Barbara's buttons <i>Marshallia mohrii</i> Beadle & F.E. Boynton
<u>Mountain golden heather</u> <i>(Hudsonia montana)</i>	<p>Fire maintained, keeps woody trees and shrubs down. (USFWS 2012)</p> <p>Limited to chilhowee quartzite ledges and outcrops found along Linville Gorge. In watershed of the Linville River. Ledge habitats exposed to direct sunlight. Edaphically maintained ecotone between bare rock and</p>	The proposed dicamba DGA uses are not expected to overlap with outcrops and ledges.	<p>2012 USFWS Mountain Golden Heather (<i>Hudsonia montana</i>) 5-Year Review: Summary and Evaluation</p> <p>1983 USFWS Mountain Golden Heather (<i>Hudsonia montana</i>) Recovery Plan</p>

Species	Habitat	Rationale	Source
	pine/ericaceous shrub community, with mtn golden heather local dominant in the ecotone. (USFWS 1983)		
Mountain sweet pitcher-plant (<i>Sarracenia rubra ssp. jonesii</i>)	It is found in the wetter parts of boggy areas in the coastal plain from southern Georgia and northern Florida to southern Mississippi. Quite often the plants can be found near the waterline. They may occasionally be submerged. While submerged, it will capture water arthropods and tadpoles. (USFWS 2013)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2013 USFWS Mountain sweet pitcher plant (<i>Sarracenia rubra ssp. jonesii</i>) 5-Year Review: Summary and Evaluation
Morefield's leather flower (<i>Clematis morefieldii</i>)	It occurs in patches near seeps and springs in rocky limestone woods, typically at elevations of 800 to 11 feet, on the south and wouthwest facing slopes of mountains in open to dense juniper-hardwoods communities	The proposed DGA uses are not expected to overlap with rocky limestone wood habitat on mountains.	1994 USFWS. Recovery Plan for Morefield's leather flower (<i>Clematis morefieldii</i>). Atlanta, Georgia. 15 pp. http://ecos.fws.gov/docs/recovery_plan/940503.pdf
Navasota ladies'-tresses (<i>Spiranthes parksii</i>)	Clearly associated with the Post Oak Savanna vegetation type of east-central Texas. Highest numbers of individuals found in lightly wooded, lightly grazed stream banks of minor tributaries associated with the Navosta and Brazos drainages (2, p.10-11). Oak Savanna associates – <i>Quercus stellata</i> , <i>Q. nigra</i> , <i>Q. marilandica</i> , <i>Ulmus</i>	The proposed dicamba DGA uses are not expected to overlap with savanna.	1984 USFWS Navasota Ladies'-tresses (<i>Spiranthes parksii</i>) Recovery Plan

Species	Habitat	Rationale	Source
	<i>alata</i> , <i>Celtis laevigata</i> , <i>Ilex vomitoria</i> , <i>Forestiera ligustrina</i> , <i>Callicarpa americana</i> , <i>Ascyrum hypericoides</i> , <i>Stillingria sylvatica</i> , and numerous herbs (USFWS 1984)		
<u>Neches River rose-mallow</u> (<u><i>Hibiscus</i> <i>dasycalyx</i></u>)	Intermittent or perennial wetlands within the Neches, Sabine, and Angelina River floodplains or Mud and Tantabogue Creek basins that contain: (a) Hydric alluvial soils and the potential for flowing water when found in depressional sloughs, oxbows, terraces, side channels, or sand bars; (b) Native woody or associated herbaceous vegetation, largely with an open canopy providing partial to full sun exposure with low levels or no nonnative species.	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2013. Designation of Critical Habitat for Texas Golden Glade cress and Neches River Rose-Mallow; Final Rule. Page 56093. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-09-11/pdf/2013-22083.pdf
<u>Nellie cory cactus</u> (<u><i>Coryphantha</i> <i>minima</i></u>)	Desert grassland. Restricted to the Caballos Naviculite Formation, a quartz formation that forms low-lying ridges that are highly resistant to erosion. The Nellie Cory cactus is usually found growing among the chips of weathered and physically fractured novaculite, often associated with spikemoss (<i>Selaginella</i> <i>sp.</i>). The plants follow the cracks in the	The proposed dicamba DGA uses are not expected to overlap with desert grassland.	1984 USFWS Recovery Plan for the Nellie Cory Cactus 2012 USFWS Davis's Green Pitaya <i>Echinocereus viridiflorus</i> <i>var. davisii</i> Houghton and Nellie Cory Cactus <i>Escobaria minima</i> (Baird) D.R. Hunt (Syn. <i>Coryphantha minima</i> Baird) Five Year Review

Species	Habitat	Rationale	Source
	<p>formation (USFWS 1984)</p> <p>Has a very clumped distribution, caespitose, plants not evenly distributed. (USFWS 2012)</p>		
<u>Pecos (=puzzle, =paradox) sunflower</u> <u>(<i>Helianthus paradoxus</i>)</u>	<p>Pecos sunflower is a wetland plant that grows on wet, alkaline soils at spring seeps, wet meadows, stream courses and pond margins. It has seven widely spaced populations in west-central and eastern New Mexico and adjacent Trans-Pecos Texas. These populations are all dependent upon wetlands from natural groundwater deposits. Incompatible land uses, habitat degradation and loss, and groundwater withdrawals are historic and current threats to the survival of Pecos sunflower. (USFWS 2005)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with wetlands.</p>	<p>USFWS 2005 Final Pecos Sunflower Recovery Plan</p> <p>Available at: http://www.fws.gov/southwest/es/documents/r2es/pecos_sunflower_final_recovery_plan.pdf </p>
<u>Persistent trillium</u> <u>(<i>Trillium persistens</i>)</u>	<p>Found in deciduous or conifer deciduous forest of steep ravines and gorges, bouldered slopes; predominantly mesic slopes, but some dry exposed slopes. Wide variety of habitat conditions – noted to occur generally under a well developed overstory but also in open or closed canopies dominated by hemlock, hemlock-white pine, hemlock-beech, white</p>	<p>The proposed dicamba DGA uses are not expected to overlap with forests.</p>	<p>1984 USFWS Persistemt Trillium (<i>Trillim persistens</i>) Recovery Plan</p>

Species	Habitat	Rationale	Source
	pine, chestnut oak-white oak, black-oak-chestnut oak, with open or nearly closed shrub cover of Rhododendron minus, Rhododendron maximum, Leucothoe axillaris, and all combinations of the above, including with no shrubs or deciduous shrubs only. (USFWS 1984)		
<u>Relict trillium</u> (<i>Trillium reliquum</i>)	This species is typically found in mature and undisturbed hardwood stands. (USFWS 1991)	The proposed dicamba DGA uses are not expected to overlap with forests.	1991 USFWS Recovery Plan for Relict Trillium (<i>Trillium reliquum</i> Freeman)
<u>Rough-leaved loosestrife</u> (<i>Lysimachia asperulaefolia</i>)	Found in ecotone between longleaf pine or oak savannas and wetter shrubby plant communities. Coastal plains and sandhills. Requires moist, open habitat. Associated with 6 different community types: low pocosin, high pocosin, wet pine flatwoods, pine savanna, streamhead pocosin, and sandhill seep. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with longleaf pine or oak savannas.	1995 USFWS Rough-leaved loosestrife recovery plan
<u>Schweinitz's sunflower</u> (<i>Helianthus schweinitzii</i>)	Currently known from roadsides, power line clearings, old pastures, woodland openings, and other sunny to semi-sunny situations. Formerly, it probably occurred in prairie-like habitats or post oak-blackjack oak savannas maintained by fires set by lightning and Native	The proposed dicamba DGA uses are not expected to overlap with prairie-like habitats.	1994 USFWS Recovery Plan

Species	Habitat	Rationale	Source
	Americans (p. i). (USFWS 1994)		
<u>Seabeach amaranth</u> <i>(Amaranthus pumilus)</i>	Barrier island beaches of the Atlantic coast, inlets, temporary habitats, may move as areas become suitable or unsuitable habitat. Overwash flats at accreting ends of islands, lower foredunes and upper strands of noneroding beaches (landward of the wrackline). Does not occur on well-vegetated sites. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with beaches.	1996 Weakley, Bucher, Murdock U.S. Fish and Wildlife Service. 1996. Recovery Plan for Seabeach Amaranth. (<i>Amaranthuspumilus</i>) <i>Rafinesque</i>). Atlanta, Georgia. http://ecos.fws.gov/docs/recovery_plan/961112b.pdf . 2007 USFWS Seabeach Amaranth Five-Year Review; http://ecos.fws.gov/docs/five_year_review/doc1068.pdf
<u>Sensitive joint- vetch</u> <i>(Aeschynomene virginica)</i>	Occurs in fresh to slightly brackish tidal river systems, within the intertidal zone where populations are flooded twice daily. Typically occur in the estuarine meander zone of tidal rivers where sediments transported from upriver settle out and extensive marshes form. Need disturbed/open habitats such as: accreting point bars that have not yet been colonized by perennial species, low swales within extensive marshes, areas of nutrient deficiencies in saturated organic sediments, or areas of muskrat herbivory. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1995 USFWS Sensitive joint-vetch recovery plan 2012 USFWS Sensitive joint-vetch 5-year review

Species	Habitat	Rationale	Source
	Majority are found in natural tidal marsh habitats, but also a few documented cases of a pocket marsh wetland, edge of a moist soybean field, and a mowed grassy strip between a manmade drainage channel and dirt road. (USFWS 2012)		
Short's bladderpod (Physaria globosa)	Soils and outcrops of calcareous geologic formations along the mainstem or tributaries of the Kentucky and Cumberland rivers. The species inhabits these outcrops and soils where they occur on steeply sloped bluffs or hillsides. The combination of calcareous outcrops and shallow soils, steep slopes, and hot and dry conditions regulates the encroachment of herbaceous and woody species that exclude Short's bladderpod from vegetation communities present on more mesic sites.	The proposed dicamba DGA uses are not expected to occur in areas where calcareous outcrops, shallow soils, steep slopes and hot and dry conditions prevent the encroachment of herbaceous and woody species such as soybean and cotton.	2014. USFWS. Designation of Critical Habitat for Physaria globosa (Short's bladderpod), Helianthus verticillatus (whorled sunflower), and Leavenworthia crassa (fleshy-fruit gladeceess) Final Rule. Federal Register Federal Register Volume 79 Number 165 August 26, 2014 http://www.gpo.gov/fdsys/pkg/FR-2014-08-26/pdf/2014-19558.pdf
Short's goldenrod (Solidago shortii)	The habitat of Short's goldenrod is open areas in full sun or partial shade. Known occurrences are in limestone cedar glades, open eroded areas, edges, of open oak-hickory woods, cedar thickets, pastures, old fields, power line rights-of-way and rock ledges along rights-of-way. Cedar glades and	The proposed dicamba DGA salt uses are not expected to overlap with glades, woodland edges, pastures, or other habitat favorable for goldenrod growth.	1988 USFWS. Recovery Plan for Short's Goldenrod. U.S. Fish and Wildlife Service, Atlanta, Georgia. 27 pp. http://ecos.fws.gov/docs/recovery_plan/shortsgrodRP.pdf USFWS. 2007. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc1609.pdf

Species	Habitat	Rationale	Source
	woodland edges appear to be the natural habitat. Short's goldenrod was known historically and currently only from Kentucky when the Recovery Plan was written in 1988 (US FWS, pp. 3-4). An Indiana occurrence was located in 2001 along the Blue River in riparian habitat (US FWS, 2007, p. 6).		
Slender rush-pea <i>(Hoffmannseggia tenella)</i>	Occurs in patches of native short and mid-grass prairie (specifically associated with buffalograss, Texas wintergrass (<i>Stipa leucotrica</i>) and Texas grama (<i>Bouteloua rigidiset</i>) adjacent to watercourses, such as permanent or intermittent creeks. Restricted to the Texas Coastal Bend counties of Nueces and Kleberg. Eco-region is Gulf Prairies and Marshes biotic zone. Occurs on slopes (20 degrees max), along drainages, usually located in areas of short or sparse vegetation since it can't compete with taller grasses. Has been found on slopes close to mesquite-granjeno woodland areas and where shrubs are low. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with prairie.	2008 USFWS Slender Rush-pea (<i>Hoffmannseggia tenella</i>) 5 Year Review: Summary and Evaluation

Species	Habitat	Rationale	Source
<u>Small-anthered bittercress</u> (<i>Cardamine micranthera</i>)	<p>Native to small streambank seeps, adjacent sandbars, and stream edges in the Dan River drainage of the North Carolina and Virginia piedmont. (USFWS 1991)</p> <p>This plant occurs in moist and wet, shady areas near streams and in dim woodlands. Small-anthered bittercress is known only from the Dan River basin in north-central North Carolina (Stokes County) and south-central Virginia (Patrick County). (USFWS 1998)</p>	The proposed dicamba DGA uses are not expected to overlap with stream edges.	<p>1991 USFWS Recovery Plan for the Small-anthered bittercress <i>Cardamine micranthera</i></p> <p>1998 USFWS Recovery Plan for the <i>Cardamine micranthera</i></p>
<u>Smooth coneflower</u> (<i>Echinacea laevigata</i>)	The habitat of smooth coneflower consists of open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium- and calcium-rich soils associated with amphibolite, dolomite, or limestone (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with open woods, barrens, or bluffs.	2011 USFWS Smooth Coneflower (<i>Echinacea laevigata</i>) 5-Year Review: Summary and Evaluation
<u>Sneed pincushion cactus</u> (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)	The Sneed and Lee pincushion cacti grow in semi-desert grassland (Brown, 1982). The Sneed pincushion cactus is restricted to limestone and grows in cracks on vertical cliffs or ledges. The Sneed pincushion cactus grows at an elevation of 1,200-2,350 m in areas where the average	The proposed dicamba DGA uses are not expected to overlap with semi-desert grasslands.	1986 USFWS Recovery Plan for the Sneed and Lee Pincushion Cacti. Pages 8-9. Available at: http://ecos.fws.gov/docs/recovery_plan/860321b.pdf

Species	Habitat	Rationale	Source
	precipitation varies from 19.7 to 40 cm per year. Edaphic requirements are poorly understood. (USFWS 1986)		
<u>South Texas ambrosia</u> (<i>Ambrosia cheiranthifolia</i>)	Grows in the Gulf coastal grasslands of southern Texas. The plant is found in grassland and mesquite shrubland habitat on various soils. Associated with sites where native short-grass prairie species persist. Also on moderately disturbed sites such as cemeteries, right-of-ways, roadsides, parkfields, and eroded areas along creeks. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with grasslands.	2010 USFWS South Texas Ambrosia (<i>Ambrosia cheiranthifolia</i>) 5-Year Review: Summary and Evaluation
<u>Star cactus</u> (<i>Astrophytum asterias</i>)	Star cactus grows on sparsely vegetated areas in gravelly, saline clays or loams at low elevations in the Rio Grande Plains. (USFWS 2013) This species grows in grasslands and thorn shrub of the Rio Grande (US FWS 2003)	The proposed dicamba DGA uses are not expected to overlap with grasslands or thorn shrub.	USFWS 2013. Star Cactus (<i>Astrophytum asterias</i>) 5-Year Review: Summary and Evaluation Available at: http://www.fws.gov/southwest/es/Documents/R2ES/Star_Cactus_5-yr_Review_FINAL_June2013.pdf US FWS 2003. Recovery Plan. Available at: http://ecos.fws.gov/docs/recovery_plan/031106.pdf
<u>Swamp pink</u> (<i>Helonias bullata</i>)	Swamp pink is found in a variety of wetland habitats, including swampy forested wetlands bordering small streams; headwater wetlands; sphagnous, hummocky, dense Atlantic white cedar swamps; Blue Ridge swamps;	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1991 USFWS Swamp Pink (<i>Helonias bullata</i>) Recovery Plan Available at: http://ecos.fws.gov/docs/recovery_plan/910930c.pdf

Species	Habitat	Rationale	Source
	meadows; bogs; and spring seepage areas (USFWS 1991)		
<u>Terlingua Creek cat's-eye</u> (<i>Cryptantha crassipes</i>)	Grows on xeric, barren, gypsiferous, low rounded hills and gentle slopes composed of small platelets of stiltly limestone in the Trans-Pecos shrub savannah (p. iii). Obligate upland (p. iii). (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with shrub savanna.	1994 USFWS Recovery Plan Available at: http://ecos.fws.gov/docs/recovery_plan/940405.pdf
<u>Texas ayenia</u> (<i>Ayenia limitaris</i>)	This species is associated with forest and scrubland of river flood plains and deltas in south Texas and northern Mexico. Occurs in open ground or under an open canopy, within or on the edges of thickets, on dry, alluvial clay soils. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with forests or scrubland.	2010 USFWS Texas Ayenia (Tamaulipan Kidney-petal), Ayenia limitaris Cristóbal, 5-Year Review Available at: http://ecos.fws.gov/docs/five_year_review/doc3241.pdf
<u>Texas Golden Gladecress</u> (<i>Leavenworthia texana</i>)	Open, sunny exposures of Weches outcrops within Weches glade plant communities that are characterized by the species listed in Table 1, with relatively thin, rocky soils that are classified within Nacogdoches, Trawick, or Bub soils mapping units as identified by the NRCS soil survey maps. There must be bare, exposed bedrock on top-level surfaces or rocky ledges with very shallow	The proposed dicamba DGA uses are not expected to overlap with Weches outcrops.	USFWS 2013. Designation of Critical Habitat for Texas Golden Gladecress and Neches River Rose-Mallow; Final Rule. Page 56087. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-09-11/pdf/2013-22083.pdf

Species	Habitat	Rationale	Source
	depressions where rainwater can pool or seepage can collect. (USFWS 2013)		
<u>Texas poppy-mallow</u> (<i>Callirhoe scabriuscula</i>)	Rolling Plains Vegetation zone of Texas. Deep, alluvial sands deposited in Runnels County, Texas (USFWS 1985)	The proposed dicamba DGA uses are not expected to overlap with the Rolling Plans.	1985 USFWS Texas poppy-mallow (<i>Callirhoe scabriuscula</i>): Recovery Plan
<u>Texas prairie dawn-flower</u> (<i>Hymenoxys texana</i>)	This plant grows only in the grasslands of the Gulf Coastal Plain in Texas. It can be found on open, barren stretches of saline sandy soil at the base of Mima mounds. (USFWS 1989)	The proposed dicamba DGA uses are not expected to overlap with grasslands.	1989 USFWS <i>Hymenoxys texana</i> Recovery Plan
<u>Texas snowbells</u> (<i>Styrax texanus</i>)	<p>Endemic to cliffs along rivers, streams, and dry creek beds in the Edwards Plateau. Grows in limestone crevices of creek and river bluffs. Elevations are 30m to 914 m. Shallow soils, wide range of textures. Lightly wooded vertical limestone and dolomite cliffs, mapped as Segovia and Fort Terrett members of the Edwards Limestone, the Devil's River Limestone, and the Glen Rose Formation. Numerous trees, shrubs, and herbs associated. (USFWS 1987)</p> <p>Moist habitats like river drainages, canyons, and draws, which are</p>	The proposed dicamba DGA uses are not expected to overlap with cliffs.	<p>1987 USFWS Texas Snowbells (<i>Styrax texana</i>) Recovery Plan</p> <p>2008 USFWS Texas Snowbells (<i>Styrax platanifolius</i> ssp. <i>Texanus</i>) 5-Year Review Summary and Evaluation</p>

Species	Habitat	Rationale	Source
	abundant in the Edwards Plateau. Surface water may not be present, but sites have subsurface water or collect runoff. Most plants are found where they get at least partial shade during the day from surrounding vegetation. Many occur on level terrain, but are most often described on vertical cliffs possibly because of herbivory on more accessible terrain. (USFWS 2008)		
<u>Texas trailing phlox (<i>Phlox nivalis</i> ssp. <i>texensis</i>)</u>	Sandy soils of open pine woodlands. Pineywoods vegetational area. May also be associated with the Gulf Prairies and Marshes vegetational areas, but this is not confirmed by historical or extant records. Plant prefers open canopy and at least some ground cover, and intermediate seral stages in community succession. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with pine woodlands.	1995 USFWS Texas trailing phlox recovery plan
<u>Texas wild-rice (<i>Zizania texana</i>)</u>	This plant grows in clear flowing spring-fed waters. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with water bodies.	2008 USFWS 5-Year Reviews of 28 Southwestern Species
<u>Tobusch fishhook cactus (<i>Sclerocactus brevipalmatus</i> ssp. <i>tobuschii</i>)</u>	The cacti occur in gravelly soils along rivers and plants are periodically disturbed by flooding. Severe floods will destroy plants but some disturbance appears to benefit the species because non-flooded	The proposed dicamba DGA uses are not expected to overlap with streams, rivers or other water bodies.	USFWS 1987. Tobusch fishhook cactus recovery plan. Available at: http://ecos.fws.gov/docs/recovery_plan/870318a.pdf USFWS 2010. Tobusch Fishhook Cactus Completed 5-Year Review. Page 27. Available at:

Species	Habitat	Rationale	Source
	<p>areas become very grassy which tends to crowd out the cacti (USFWS 1987).</p> <p>However by the early 1990s many new locations had been discovered, and the species was known from eight counties. Most sites were no longer in the floodplain, but found from lower slopes to ridge tops (USFWS 2010)</p>		http://ecos.fws.gov/docs/five_year_review/doc3073.pdf
<u>Walker's manioc</u> <u>(<i>Manihot walkerae</i>)</u>	<p>An understory species that inhabits open brushlands in the Lower Rio Grande Valley of Texas and adjacent Mexico (p. i). Most manihot species are found in relatively dry regions, and only a few are typically found in rain forest regimes. Those species found in rain forest are typically found in openings in the forest... these considerations lead us to the hypothesis that most species are heliophiles capable of growth only when there is no shading, and that many of them are "weedy" types, capable of invasion into open areas (p. 6). (USFWS 2007)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with open brushlands.</p>	<p>2007 USFWS Recovery Plan</p>
<u>White bladderpod</u> <u>(<i>Lesquerella pallida</i>)</u>	<p>The plant grows on openings in oak, hickory, and pine woods. It is limited to a part of the Piney Woods region on the Gulf</p>	<p>The proposed dicamba DGA uses are not expected to overlap with forests.</p>	<p>1992 USFWS White Bladderpod (<i>Lesquerella padilla</i>) recovery plan</p>

Species	Habitat	Rationale	Source
	Coastal Plain. (USFWS 1992)		
<u>White irisette</u> (<u>Sisyrinchium</u> <u>dichotomum</u>)	This rare herb is typically found in open dry to mesic oak-hickory forests on mid-elevation mountain slopes and on open, disturbed sites, such as woodland edges and roadsides. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with forests.	1995 US FWS RECOVERY PLAN for White Irisette (<i>Sisyrinchitan dichotomum</i>) Bicknell
<u>White-haired goldenrod</u> (<u>Solidago</u> <u>albopilosa</u>)	Grows in sandy soil behind the drip line of sandstone rock-shelters and on rock ledges. It is very rarely found in open sunlight and is never found in the darkest recesses of rock-shelters (p. i). (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with sandstone rock shelters.	1993 USFWS Recovery Plan
<u>Zapata bladderpod</u> (<u>Lesquerella</u> <u>thamnophila</u>)	Zapata bladderpod is known to occur on graveled to sandy-loam upland terraces above the Rio Grande flood plain. The known populations of Zapata bladderpod are associated with highly calcareous sandstones and clays, and occur within a community of shrub species. Zapata bladderpod occurs as an herbaceous component of an open <i>Leucophyllum frutescens</i> (cenizo) - <i>Acacia berlanderi</i> (guajillo) shrubland alliance (Nature Serve 2002) (Figure 4). Both	The proposed dicamba DGA uses are not expected to overlap with shrubland.	2004 USFWS Zapata Bladderpod (<i>Lesquerella thamnophila</i>) Recovery Plan

Species	Habitat	Rationale	Source
	plant communities dominate upland habitats on shallow soils near the Rio Grande (Diamond et al. 1987). These shrub lands are sparsely vegetated due to the shallow, fast-draining, highly erosional soils and semi-arid climate. (USFWS 2004)		

Appendix 3

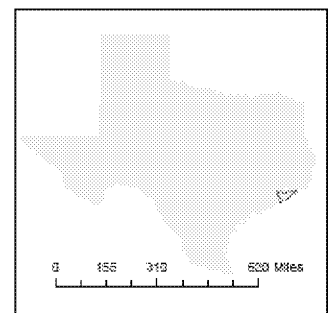
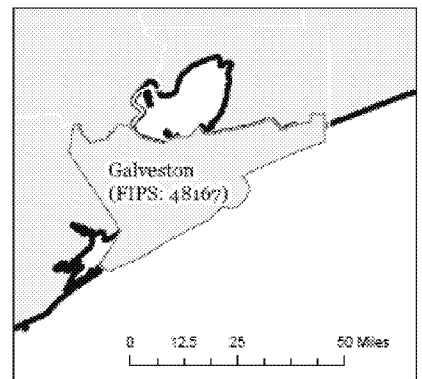
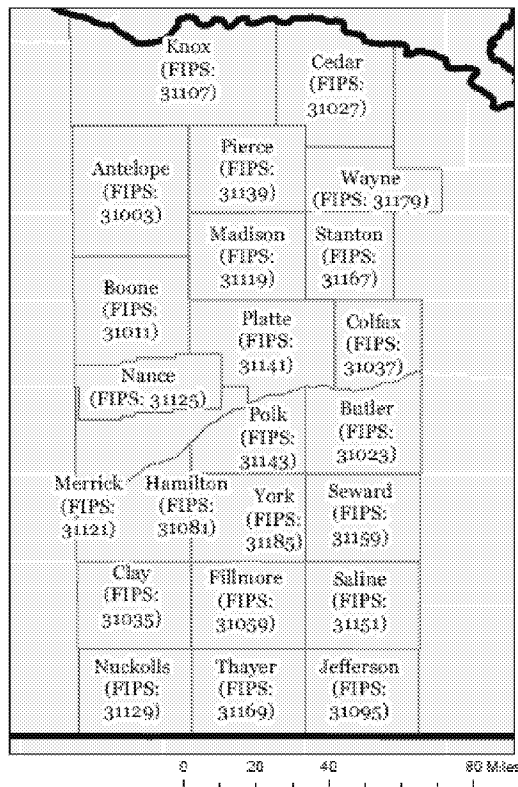
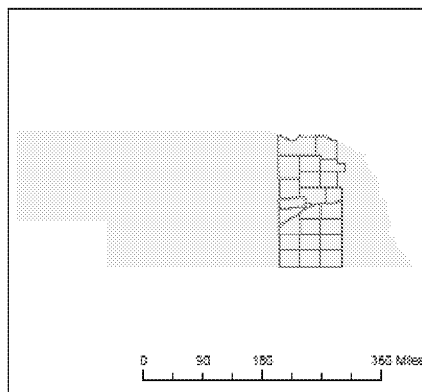
Input parameters for TIM simulation for calculating mortality to Eskimo curlew exposed to dicamba

Parameter	Value	Comments
pesticide name	dicamba	none
crop name	Corn, soybean and cotton	none
species name	Eskimo curlew	
Generic bird # (values of 1-30 are generic, 0 = custom)	0	
Passerine ? (yes=1, no = 0)	0	
nest type (0 =altricial, 1 = precocial)	1	
Number of birds (trials) simulated	10,000	
Flock size	50	Most recent estimate of population size
Random number seed (Enter 0 if user does not select a seed)	0	
Turns QC reports on (1) or off (0)	0	
Turns TIM executable call for user input on (1) or off (0)	0	
Turns MCnest outputs on (1) or off (0)	0	
Food switch	1	
Drinking water puddle switch	1	
Drinking water dew switch	1	
Inhalation vapor switch	0	The maximum vapor concentration at saturation (calculated by STIR) is 2.14e-3 mg/L. Since the available rat inhalation toxicity data did not establish an LC50 at a level that is orders of magnitude higher (i.e., 5.3 mg/L, MRID 00263861), this route of exposure is not considered of toxicological concern.
Inhalation spray switch	1	This is automatically turned off by the model due to the crop height.
Dermal contact switch	1	
Dermal spray switch	1	This is automatically turned off by the model due to the crop height.
Spray drift switch	0	Spray drift mitigations in place
Number of days simulated	3	Assume that while the birds are moving through the area during migration, they will stop and forage in an area for 3 d.
Number of applications	1	Assume that birds land in field on day of application
Rate of application #1 (lb a.i./A)	1.0	Proposed label
Interval between app1 and 2 (days)	0	

Parameter	Value	Comments
Rate of application #2 (lb a.i./A)	0	
Interval between app2 and 3 (days)	0	
Rate of application #3 (lb a.i./A)	0	
Interval between app3 and 4 (days)	0	
Rate of application #4 (lb a.i./A)	0	
Interval between app 4 and 5 (days)	0	
Rate of application #5 (lb a.i./A)	0	
Time of first application (hour)	8	Assume that application is made in the morning.
Application method (1 = Air, 2 = Ground Broadcast, 3 = Ground Banded, 4 = Ground infurrow, 5 = Airblast)	2	Proposed label
droplet spectrum for air and ground, (1= very fine to fine, 2 = fine to medium, 3 = medium to coarse (air only), 4 = coarse to very coarse (air only))	1	Since spray drift switch is turned off, this parameter value does not impact the model's results.
Spray height (m)	0.61	Assume 24" boom height.
Spray duration (min)	0.5	Default
Crop height (m)	0.127	Assumed height at time of 3 rd application (4 weeks after emergence).
Plant(crop) mass (kg/ha)	1	Default value. Not used because inhalation routes are turned off.
Crop type, (1= field, 2= orchard, 3= vineyard)	1	
Fraction of edge habitat receiving drift	0	
Fraction of organic carbon in soil	0.015	Default
Bulk density of soil (kg/L)	1.5	Default
Morning feeding start times: min and max	4 5	Default (Lebanon KS)
Morning feeding end times: min and max	6 10	
afternoon feeding start times: min and max	16 19	
afternoon feeding end times: min and max	20 21	
Proportion of daily feeding taking place in morning: min and max	0.4 0.6	Varying proportions of food distributed between morning and afternoon.
Gorging factor	3	Assume that birds gorge when they land. Factor of 3x normal feeding based on ECOFRAM recommendation.
Body weight (g): mean, sd, min, max	362, 36, 273, 454	Dunning 1984
feeding category: (1 = insectivore, 2 = herbivore, 3 = granivore, 4 = omnivore)	1	
Fraction of each food item: insects, seeds, fruit, grass, broadleaf	1.0, 0, 0, 0, 0	Recovery plan

Parameter	Value	Comments
For juveniles: fraction of each food item: insects, seeds, fruit, grass, broadleaf	1.0, 0, 0, 0, 0	Note that although there are juvenile parameters included here, these values are not the focus of this report. The juvenile parameters are used by the MCnest model.
Resident status (1=field, 0 = edge)	0	
Frequency on field: mean, min, max	0.1, 0, 1	Mean frequency on field of species is unknown. Mean values of 10% and 90% used to bound risk.
Fidelity factor (Q), (edge residents = 0.6, field residents = 0.8)	0.6	Default
Contaminated fraction of food	1.0, 1.0, 1.0, 1.0, 1.0	
Food item half-lives (days)	8.5 8.5 8.5 8.5 8.5	Foliar dissipation half-life used for all food items.
Aerobic soil metabolism half-life (days)	18	Aerobic soil metabolism half-life. Stable to hydrolysis.
Koc (L/kg-oc)	13.4	MRID 42774101
Kow	0.71	Based on LogD
Henry's law constant (atm/m ³ -mol)	1.17e-9	
Solubility in water (mg/L)	6100	SANDZONE Safety Data Sheet (Nov 1989)
Dislodgable foliar residue adjustment factor	0.48	default
Dermal adsorption fraction	1	default
avian acute oral LD50 (mg a.i./kg-bw)	188	From bobwhite quail study.
Slope of avian oral LD50	4.5	No value is available. Assume default.
Avian acute inhalation LD50 (mg a.i./kg-bw)	0	Not available.
Rat inhalation LD50 (mg a.i./kg-bw)	≥594	Value converted from LC50 value. (MRID 00263861)
Rat acute oral LD50 (mg a.i./kg-bw)	2740	MRID 00078444
Respiratory physiology adjustment factor	3.2	Default for bird body weight.
Chemical specific avian dermal LD50 (enter 0 if no value is available)	0	None
Food matrix adjustment factor	1	No data are available. Assume default.
Fraction of pesticide retained from one hour to the next	0.99	MRID 43245202
ratio of juvenile to adult toxicity	1	No data are available. Assume default.

Appendix 4
Bird Species County Land cover Information
Eskimo Curlew



	Corn	Cotton	Rice	Soybean	Wheat	Vegetable/ ground fruit	Orchards/ grapes	Other grains	Other Row crops	Other crops	Pasture/ hay/ forage
Full County Range	12,971,726	0	5,016	7,312,078	560,712	21,885	582	261,925	2,495	10,263	1,270,357
n=24											
Texas (n=1)	0	0	5,016	103	232	18	492	2820	0	0	16,625
Nebraska (n=23)	12,971,726	0	0	7,311,975	560,480	21,867	90	259,105	2,495	10263	1253732

Appendix 5
Critical Habitat Designations and PCE Descriptions

Summary of 14 Listed Species Identified as being on Agricultural Fields with and without Critical Habitat Designations for AL, GA, KY, MI, NC, SC and TX Assessed for dicamba DGA salt

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species with Critical Habitat Designations (5 Species)³</i>		
Houston toad (<i>Bufo houstonensis</i>)	Bastrop and Burleson Counties, Texas. Primary Constituent Elements not identified.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=D004#crithab http://ecos.fws.gov/docs/federal_register/fr179.pdf
Indiana bat (<i>Myotis sodalis</i>)	Critical habitat designations are either mines or caves.	http://ecos.fws.gov/docs/federal_register/fr161.pdf
Louisiana black bear (<i>Ursus americanus luteolus</i>)	PCE: Relatively inaccessible terrain, thick understory vegetation and abundant food sources in the form of shrubs or tree borne soft or hard mast. Currently found in bottomland hardwood forest communities. Home range very dependent on forest cover.	http://www.gpo.gov/fdsys/pkg/FR-2009-03-10/pdf/E9-4536.pdf#page=1
Virginia big-eared bat (<i>Corynorhinus</i> (= <i>Plecotus</i>) <i>townsendii virginianus</i>)	Critical habitat designations are caves.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A080#crithab http://ecos.fws.gov/docs/federal_register/fr366.pdf
Whooping crane (<i>Grus americana</i>)	PCE: All areas proposed in this rule would provide food, water, and other nutritional or physiological needs of the whooping crane during spring or fall migration. Consumption of some cereal crops in adjacent croplands during migration period. Direct relatable resources to agricultural field possibly treated with 2,4-D choline.	http://ecos.fws.gov/docs/federal_register/fr237.pdf
<i>Species without critical habitat designations (10 species)</i>		
American burying beetle (<i>Nicrophorus americanus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=I028#crithab
Attwater's greater prairie-chicken (<i>Tympanuchus cupido attwateri</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B000#crithab
Eastern indigo snake (<i>Drymarchon corais couperi</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C026#crithab
Eskimo curlew (<i>Numenius borealis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B01A#crithab

³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Gopher tortoise (<i>Gopherus polyphemus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C044#crithab
Gulf Coast jaguarundi (<i>Herpailurus (=Felis) yagouaroundi cacomitli</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A05H#crithab
Lesser prairie-chicken (<i>Tympanuchus pallidicinctus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0AZ#crithab
Ocelot (<i>Leopardus (Felis) pardalis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A084#crithab
Red wolf (<i>Canis rufus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00F#crithab

Summary of 292 Listed Species Identified as being off Agricultural Fields with and without Critical Habitat Designations for AL, GA, KY, MI, NC, SC and TX Assessed for dicamba DGA salt

Critical Habitat Designation	Species Name
<i>Species with Critical Habitat Designations (113 Species)⁴</i>	[Unnamed] ground beetle (<i>Rhadine exilis</i>)
	[Unnamed] ground beetle (<i>Rhadine infernalis</i>)
	Alabama beach mouse (<i>Peromyscus polionotus ammobates</i>)
	Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)
	Alabama moccasinshell (<i>Medionidus acutissimus</i>)
	Alabama pearlshell (<i>Margaritifera marrianae</i>)
	Alabama sturgeon (<i>Scaphirhynchus suttkusi</i>)
	Altamaha Spiny mussel (<i>Elliptio spinosa</i>)
	Amber darter (<i>Percina antesella</i>)
	Appalachian elktoe (<i>Alasmidonta raveneliana</i>)
	Arkansas River shiner (<i>Notropis girardi</i>)
	Austin blind salamander (<i>Eurycea waterlooensis</i>)
	Braken Bat Cave Meshweaver (<i>Cicurina venii</i>)
	Braun's rock-creep (<i>Arabis perstellata</i>)
	Cahaba shiner (<i>Notropis cahabae</i>)
	Canada lynx (<i>Lynx canadensis</i>)
	Cape Fear shiner (<i>Notropis mekistocholas</i>)
	Carolina heelsplitter (<i>Lasmigona decorata</i>)
	Chipola slabshell (<i>Elliptio chipolaensis</i>)

⁴ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

	Choctaw bean (<i>Villosa choctawensis</i>)
	Cokendolpher Cave Harvestman (<i>Texella cokendolpheri</i>)
	Comal Springs dryopid beetle (<i>Stygoparnus comalensis</i>)
	Comal Springs riffle beetle (<i>Heterelmis comalensis</i>)
	Conasauga logperch (<i>Percina jenkinsi</i>)
	Coosa moccasinshell (<i>Medionidus parvulus</i>)
	Cumberland darter (<i>Etheostoma susanae</i>)
	Cumberland elktoe (<i>Alasmidonta atropurpurea</i>)
	Cumberlandian combshell (<i>Epioblasma brevidens</i>)
	Dark pigtoe (<i>Pleurobema furvum</i>)
	Devils River minnow (<i>Dionda diaboli</i>)
	Diamond Y Spring snail (<i>Pseudotryonia adamantina</i>)
	Diminutive Amphipod (<i>Gammarus hyalleloides</i>)
	Fat three-ridge (mussel) (<i>Ambblema neislerii</i>)
	Finelined pocketbook (<i>Lampsilis altilis</i>)
	Fleshy-fruit gladecress (<i>Leavenworthia crassa</i>)
	Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)
	Fountain darter (<i>Etheostoma fonticola</i>)
	Frosted Flatwoods salamander (<i>Ambystoma cingulatum</i>)
	Fuzzy pigtoe (<i>Pleurobema strodeanum</i>)
	Georgetown salamander (<i>Eurycea naufragia</i>)
	Georgia pigtoe (<i>Pleurobema hanleyianum</i>)
	Golden sedge (<i>Carex lutea</i>)
	Goldline darter (<i>Percina aurolineata</i>)
	Gonzales springsnail (<i>Tryonia circumstriata</i>)
	Government Canyon Bat Cave Meshweaver (<i>Cicurina vespera</i>)
	Government Canyon Bat Cave Spider (<i>Neoleptoneta microps</i>)
	Green sea turtle (<i>Chelonia mydas</i>)
	Gulf moccasinshell (<i>Medionidus penicillatus</i>)
	Gulf sturgeon (<i>Acipenser oxyrinchus desotoi</i>)
	Hawksbill sea turtle (<i>Eretmochelys imbricata</i>)
	Helotes mold beetle (<i>Batrisodes venyivi</i>)
	Hine's emerald dragonfly (<i>Somatochlora hineana</i>)
	Interrupted (=Georgia) Rocksnail (<i>Leptoxis foremani</i>)
	Jollyville Plateau salamander (<i>Eurycea tonkawae</i>)
	Karner blue butterfly (<i>Lycaeides melissa samuelis</i> Y)
	Kentucky cave shrimp (<i>Palaemonias ganteri</i>)
	Kentucky glade cress (<i>Leavenworthia exigua laciniata</i>)
	Leatherback sea turtle (<i>Dermochelys coriacea</i>)
	Leon Springs pupfish (<i>Cyprinodon bovinus</i>)
	Loggerhead sea turtle (<i>Caretta caretta</i>)
	Madla's Cave Meshweaver (<i>Cicurina madla</i>)
	Mexican spotted owl (<i>Strix occidentalis lucida</i>)
	Mountain golden heather (<i>Hudsonia montana</i>)
	Narrow pigtoe (<i>Fusconaia escambia</i>)
	Neches River rose-mallow (<i>Hibiscus dasycalyx</i>)

	North Atlantic Right Whale (<i>Eubalaena glacialis</i>)
	Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)
	Oval pigtoe (<i>Pleurobema pyriforme pyriforme</i>)
	Ovate clubshell (<i>Pleurobema perovatum</i>)
	Oyster mussel (<i>Epioblasma capsaeformis</i>)
	Peck's cave amphipod (<i>Stygobromus</i> (= <i>Stygonectes</i>) <i>pecki</i>)
	Pecos (=puzzle, =paradox) sunflower (<i>Helianthus paradoxus</i>)
	Pecos assiminea snail (<i>Assiminea pecos</i>)
	Perdido Key beach mouse (<i>Peromyscus polionotus trissyllepsis</i>)
	Phantom springsnail (<i>Pyrgulopsis texana</i>)
	Phantom tryonia (<i>Tryonia cheatumi</i>)
	Piping Plover (<i>Charadrius melodus</i>)
	Purple bankclimber (mussel) (<i>Elliptoideus sloatianus</i>)
	Pygmy Sculpin (<i>Cottus paulus</i> (= <i>pygmaeus</i>))
	Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)
	Reticulated flatwoods salamander (<i>Ambystoma bishopi</i>)
	Robber Baron Cave Meshweaver (<i>Cicurina baronia</i>)
	Rough hornsnail (<i>Pleurocera foremani</i>)
	Round Ebonyshell (<i>Fusconaia rotulata</i>)
	Rush Darter (<i>Etheostoma phytophilum</i>)
	Salado salamander (<i>Eurycea chisholmensis</i>)
	San Marcos gambusia (<i>Gambusia georgei</i>)
	San Marcos salamander (<i>Eurycea nana</i>)
	Sharpnose Shiner (<i>Notropis oxyrhynchus</i>)
	Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)
	Short's bladderpod (<i>Physaria globosa</i>)
	Slabside Pearlymussel (<i>Pleuonaia dolabelloides</i>)
	Slackwater darter (<i>Etheostoma boschungii</i>)
	Smalleye Shiner (<i>Notropis buccula</i>)
	Snail darter (<i>Percina tanasi</i>)
	Southern acornshell (<i>Epioblasma othcaloogensis</i>)
	Southern clubshell (<i>Pleurobema decisum</i>)
	Southern kidneyshell (<i>Ptychobranhus jonesi</i>)
	Southern pigtoe (<i>Pleurobema georgianum</i>)
	Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)
	Spotfin Chub (<i>Erimonax monachus</i>)
	Spruce-fir moss spider (<i>Microhexura montivaga</i>)
	Sunfish, spring pygmy (<i>Elassoma alabamae</i>)
	Tapered pigtoe (<i>Fusconaia burkei</i>)
	Texas Golden Gladecress (<i>Leavenworthia texana</i>)
	Texas wild-rice (<i>Zizania texana</i>)
	Triangular Kidneyshell (<i>Ptychobranhus greenii</i>)
	Upland combshell (<i>Epioblasma metastriata</i>)
	Vermilion darter (<i>Etheostoma chermocki</i>)
	Waccamaw silverside (<i>Menidia extensa</i>)
	West Indian Manatee (<i>Trichechus manatus</i>)

Species without Critical Habitat Designations (179 species)	Whorled Sunflower (<i>Helianthus verticillatus</i>)
	Zapata bladderpod (<i>Lesquerella thamnophila</i>)
	Alabama (=inflated) heelsplitter (<i>Potamilus inflatus</i>)
	Alabama canebrake pitcher-plant (<i>Sarracenia rubra alabamensis</i>)
	Alabama cave shrimp (<i>Palaemonias alabamiae</i>)
	Alabama lampmussel (<i>Lampsilis virescens</i>)
	Alabama leather flower (<i>Clematis socialis</i>)
	Alabama red-belly turtle (<i>Pseudemys alabamensis</i>)
	Alabama streak-sorus fern (<i>Thelypteris pilosa</i> var. <i>alabamensis</i>)
	American chaffseed (<i>Schwalbea americana</i>)
	American hart's-tongue fern (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)
	Anthony's riversnail (<i>Athearnia anthonyi</i>)
	Armored snail (<i>Pyrgulopsis</i> (=Marstonia) <i>pachyta</i>)
	Ashy dogweed (<i>Thymophylla tephroleuca</i>)
	Bachman's warbler (=wood) (<i>Vermivora bachmanii</i>)
	Barton Springs salamander (<i>Eurycea sosorum</i>)
	Bee Creek Cave harvestman (<i>Texella reddelli</i>)
	Big Bend gambusia (<i>Gambusia gaigei</i>)
	Black lace cactus (<i>Echinocereus reichenbachii</i> var. <i>albertii</i>)
	Black spored quillwort (<i>Isoetes melanospora</i>)
	Black-capped Vireo (<i>Vireo atricapilla</i>)
	Blackside dace (<i>Phoxinus cumberlandensis</i>)
	Blue Ridge goldenrod (<i>Solidago spithamea</i>)
	Blue shiner (<i>Cyprinella caerulea</i>)
	Bone Cave harvestman (<i>Texella reyesi</i>)
	Boulder darter (<i>Etheostoma wapiti</i>)
	Bunched arrowhead (<i>Sagittaria fasciculata</i>)
	Bunched cory cactus (<i>Coryphantha ramillosa</i>)
	Canby's dropwort (<i>Oxypolis canbyi</i>)
	Carolina northern flying squirrel (<i>Glaucomys sabrinus coloratus</i>)
	Cherokee darter (<i>Etheostoma scotti</i>)
	Chisos Mountain hedgehog Cactus (<i>Echinocereus chisoensis</i> var. <i>chisoensis</i>)
	Clear Creek gambusia (<i>Gambusia heterochir</i>)
	Clubshell (<i>Pleurobema clava</i>)
	Coffin Cave mold beetle (<i>Batrissodes texanus</i>)
	Comanche Springs pupfish (<i>Cyprinodon elegans</i>)
	Cooley's meadowrue (<i>Thalictrum cooleyi</i>)
	Copperbelly water snake (<i>Nerodia erythrogaster neglecta</i>)
	Cracking pearlymussel (<i>Hemistena lata</i>)
	Cumberland bean (pearlymussel) (<i>Villosa trabalis</i>)

Cumberland monkeyface (pearlymussel) (<i>Quadrula intermedia</i>)
Cumberland rosemary (<i>Conradina verticillata</i>)
Cumberland sandwort (<i>Arenaria cumberlandensis</i>)
Cylindrical lioplax (snail) (<i>Lioplax cyclostomaformis</i>)
Davis' green pitaya (<i>Echinocereus viridiflorus</i> var. <i>davisii</i>)
Dromedary pearlymussel (<i>Dromus dromas</i>)
Duskytail darter (<i>Etheostoma percnurum</i>)
Dwarf lake iris (<i>Iris lacustris</i>)
Dwarf wedgemussel (<i>Alasmidonta heterodon</i>)
Dwarf-flowered heartleaf (<i>Hexastylis naniflora</i>)
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)
Etowah darter (<i>Etheostoma etowahae</i>)
False killer whale (<i>Pseudorca crassidens</i>)
Fanshell (<i>Cyprogenia stegaria</i>)
Fat pocketbook (<i>Potamilus capax</i>)
Finback whale (<i>Balaenoptera physalus</i>)
Finerayed pigtoe (<i>Fusconaia cuneolus</i>)
Flat pebblesnail (<i>Lepyrium showalteri</i>)
Flat pigtoe (<i>Pleurobema marshalli</i>)
Flattened musk turtle (<i>Sternotherus depressus</i>)
Florida torreyia (<i>Torreya taxifolia</i>)
Fringed campion (<i>Silene polypetala</i>)
Gentian pinkroot (<i>Spigelia gentianoides</i>)
Golden-cheeked warbler (=wood) (<i>Dendroica chrysoparia</i>)
Gray bat (<i>Myotis grisescens</i>)
Green pitcher-plant (<i>Sarracenia oreophila</i>)
Hairy rattleweed (<i>Baptisia arachnifera</i>)
Harperella (<i>Ptilimnium nodosum</i>)
Heavy pigtoe (<i>Pleurobema taitianum</i>)
Heller's blazingstar (<i>Liatris helleri</i>)
Hinckley oak (<i>Quercus hinckleyi</i>)
Houghton's goldenrod (<i>Solidago houghtonii</i>)
Humpback whale (<i>Megaptera novaeangliae</i>)
Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>)
James spinymussel (<i>Pleurobema collina</i>)
Johnston's frankeni (<i>Frankenia johnstonii</i>)
Kemp's ridley sea turtle (<i>Lepidochelys kempii</i>)
Kirtland's Warbler (<i>Setophaga kirtlandii</i>)
Kral's water-plantain (<i>Sagittaria secundifolia</i>)
Kretschmarr Cave mold beetle (<i>Texamaurops reddelli</i>)
Lacy elimia (snail) (<i>Elimia crenatella</i>)
Lakeside daisy (<i>Hymenoxys herbacea</i>)
Large-flowered skullcap (<i>Scutellaria montana</i>)
Large-fruited sand-verbena (<i>Abronia macrocarpa</i>)
Leafy prairie-clover (<i>Dalea foliosa</i>)

	Least tern (<i>Sterna antillarum</i>)
	Little Aguja (=Creek) Pondweed (<i>Potamogeton clystocarpus</i>)
	Little amphianthus (<i>Amphianthus pusillus</i>)
	Littlewing pearlymussel (<i>Pegias fabula</i>)
	Lloyd's Mariposa cactus (<i>Echinomastus mariposensis</i>)
	Louisiana quillwort (<i>Isoetes louisianensis</i>)
	Lyrate bladderpod (<i>Lesquerella lyrata</i>)
	Mat-forming quillwort (<i>Isoetes tegetiformans</i>)
	Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)
	Miccosukee gooseberry (<i>Ribes echinellum</i>)
	Michaux's sumac (<i>Rhus michauxii</i>)
	Michigan monkey-flower (<i>Mimulus michiganensis</i>)
	Mitchell's satyr Butterfly (<i>Neonympha mitchellii mitchellii</i>)
	Mohr's Barbara button (<i>Marshallia mohrii</i>)
	Morefield's leather flower (<i>Clematis morefieldii</i>)
	Mountain sweet pitcher-plant (<i>Sarracenia rubra</i> ssp. <i>Jonesii</i>)
	Navasota ladies'-tresses (<i>Spiranthes parksii</i>)
	Nellie cory cactus (<i>Coryphantha minima</i>)
	No common name (<i>Geocarpon minimum</i>)
	Noonday globe (<i>Patera clarki nantahala</i>)
	Northern aplomado falcon (<i>Falco femoralis septentrionalis</i>)
	Northern riffleshell (<i>Epioblasma torulosa rangiana</i>)
	Orangefoot pimpleback (pearlymussel) (<i>Plethobasus cooperianus</i>)
	Orangenacre mucket (<i>Lampsilis perovalis</i>)
	Painted rocksnail (<i>Leptoxis taeniata</i>)
	Pale lilliput (pearlymussel) (<i>Toxolasma cylindrellus</i>)
	Palezone shiner (<i>Notropis albizonatus</i>)
	Pallid sturgeon (<i>Scaphirhynchus albus</i>)
	Pecos gambusia (<i>Gambusia nobilis</i>)
	Persistent trillium (<i>Trillium persistens</i>)
	Pink mucket (pearlymussel) (<i>Lampsilis abrupta</i>)
	Pitcher's thistle (<i>Cirsium pitcheri</i>)
	Plicate rocksnail (<i>Leptoxis plicata</i>)
	Pondberry (<i>Lindera melissifolia</i>)
	Price's potato-bean (<i>Apios priceana</i>)
	purple cat's paw (=purple cat's paw pearlymussel) (<i>Epioblasma obliquata obliquata</i>)
	Rayed Bean (<i>Villosa fabalis</i>)
	Red Hills salamander (<i>Phaeognathus hubrichti</i>)
	Red-cockaded woodpecker (<i>Picoides borealis</i>)
	Relict darter (<i>Etheostoma chienense</i>)
	Relict trillium (<i>Trillium reliquum</i>)
	Ring pink (mussel) (<i>Obovaria retusa</i>)
	Roan Mountain bluet (<i>Hedyotis purpurea</i> var. <i>montana</i>)
	Rock gnome lichen (<i>Gymnoderma lineare</i>)

Roseate tern (<i>Sterna dougallii dougallii</i>)
Rough pigtoe (<i>Pleurobema plenum</i>)
Rough-leaved loosestrife (<i>Lysimachia asperulaefolia</i>)
Round rocksnail (<i>Leptoxis ampla</i>)
Running buffalo clover (<i>Trifolium stoloniferum</i>)
Saint Francis' satyr butterfly (<i>Neonympha mitchellii francisci</i>)
Schweinitz's sunflower (<i>Helianthus schweinitzii</i>)
Seabeach amaranth (<i>Amaranthus pumilus</i>)
Sensitive joint-vetch (<i>Aeschynomene virginica</i>)
Sheepnose Mussel (<i>Plethobasus cyphus</i>)
Shiny pigtoe (<i>Fusconaia cor</i>)
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)
Short's goldenrod (<i>Solidago shortii</i>)
Slender campeloma (<i>Campeloma decampi</i>)
Slender rush-pea (<i>Hoffmannseggia tenella</i>)
Small whorled pogonia (<i>Isotria medeoloides</i>)
Small-anthered bittercress (<i>Cardamine micranthera</i>)
Smalltooth sawfish (<i>Pristis pectinata</i>)
Smooth coneflower (<i>Echinacea laevigata</i>)
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)
Snuffbox mussel (<i>Epioblasma triquetra</i>)
South Texas ambrosia (<i>Ambrosia cheiranthifolia</i>)
Southern combshell (<i>Epioblasma penita</i>)
Southern sandshell (<i>Hamiota</i> (= <i>Lampsilis</i>) <i>australis</i>)
Spectaclecase (mussel) (<i>Cumberlandia monodonta</i>)
Sperm whale (<i>Physeter catodon</i> (= <i>macrocephalus</i>))
Spreading avens (<i>Geum radiatum</i>)
Star cactus (<i>Astrophytum asterias</i>)
Stirrupshell (<i>Quadrula stapes</i>)
Swamp pink (<i>Helonias bullata</i>)
Tar River spinymussel (<i>Elliptio steinstansana</i>)
Tennessee yellow-eyed grass (<i>Xyris tennesseensis</i>)
Terlingua Creek cat's-eye (<i>Cryptantha crassipes</i>)
Texas ayenia (<i>Ayenia limitaris</i>)
Texas blind salamander (<i>Typhlomolge rathbuni</i>)
Texas poppy-mallow (<i>Callirhoe scabriuscula</i>)
Texas prairie dawn-flower (<i>Hymenoxys texana</i>)
Texas snowbells (<i>Styrax texanus</i>)
Texas trailing phlox (<i>Phlox nivalis</i> ssp. <i>texensis</i>)
Tobusch fishhook cactus (<i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>)
Tooth Cave ground beetle (<i>Rhadine persephone</i>)
Tooth Cave pseudoscorpion (<i>Tartarocreagris texana</i>)
Tooth Cave Spider (<i>Leptoneta myopica</i>)
Tulotoma snail (<i>Tulotoma magnifica</i>)
Virginia spiraea (<i>Spiraea virginiana</i>)

	Walker's manioc (<i>Manihot walkerae</i>)
	Watercress darter (<i>Etheostoma nuchale</i>)
	White bladderpod (<i>Lesquerella pallida</i>)
	White irisette (<i>Sisyrinchium dichotomum</i>)
	White wartyback (pearlymussel) (<i>Plethobasus cicatricosus</i>)
	White-haired goldenrod (<i>Solidago albopilosa</i>)
	Wood stork (<i>Mycteria americana</i>)
	Yellow blossom (pearlymussel) (<i>Epioblasma florentina florentina</i>)

Appendix 6

U.S. Fish and Wildlife Service Concurrence Memo for Eskimo Curlew Effects Determination

From: Swem, Ted [mailto:ted_swem@fws.gov]
Sent: Monday, May 11, 2015 5:40 PM
To: Wagman, Michael
Subject: Re: Eskimo Curlew (Dicamba ESA assessment)

Dear Mr. Wagman

Regrettably, we do concur with your determination. Although we prefer to hold out hope and have not removed the Eskimo Curlew from the list of Threatened and Endangered Species, we consider it to be "presumed extinct." We believe therefore that there are none left to encounter pesticides applied anywhere, and thus agree that the effects of the proposed action are discountable.

Thank you for checking in, though.

Ted Swem

On Mon, May 11, 2015 at 1:33 PM, Wagman, Michael <Wagman.Michael@epa.gov> wrote:

Ted Swem, Chief,

Endangered Species Branch,

Fairbanks Fish and Wildlife Field Office,

US Fish and Wildlife Service (907) 456-0441

Dear Mr. Swem

The USEPA Office of Pesticide Programs is in the process of making an effects determination for the registration of the herbicide dicamba diglycolamine (DGA) salt on cotton and soybean fields in Texas, Nebraska and Oklahoma. Use of the pesticide will be limited to ground spray application using a formulation and specific spray equipment in combination to spray drift setbacks that result in pesticide application areas of concern limited to only the actual on-field treatment site (the targeted cotton or soybean field itself).

Our review of available species location information suggests a potential for a migrant Eskimo curlew (*Numenius borealis*) passing through Texas, Nebraska and Oklahoma to encounter a treated field with dicamba DGA residues. Our analysis indicates that if such an encounter occurred, the residue levels that would trigger a concern for adverse effects to the bird. However, in reviewing the available information on the status of the Eskimo curlew¹, we have determined that individuals of the species are extremely rare. This rarity of individuals

indicates to us that the chance of an individual curlew to encounter a dicamba DGA treated cotton or soybean field would be extremely unlikely to occur. Therefore any effects of dicamba DGA salt to an Eskimo curlew would be extremely unlikely to occur.

An effect that is extremely unlikely to occur would be considered discountable in regards to an effects determination and would be consistent with a determination of Not Likely to Adversely Affect. We therefore have determined that the proposed use of dicamba DGA salt on cotton and soybeans in Texas, Nebraska and Oklahoma will Not Likely to Adversely Affect individual Eskimo curlews.

Does the United States Fish and Wildlife Service concur with our effects determination?

Sincerely,

Michael Wagman
Biologist, Environmental Risk Branch VI
Environmental Fate and Effects Division
Office of Pesticide Programs
United States Environmental protection Agency
703-347-0198

¹ Eskimo Curlew (*Numenius borealis*) 5-Year Review: Summary and Evaluation, August 31, 2011, U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks Alaska



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode : 425049

Date: March 24, 2016

MEMORANDUM

Subject: Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 11 U.S. States: (Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia).

To: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Dan Kenny, Branch Chief
Herbicide Branch
Pesticide Registration Division (7505P)
Office of Pesticide Programs

From: Elizabeth Donovan, Biologist
Michael Wagman, Biologist
Monica Wait, Risk Assessment Process Leader
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Elizabeth Donovan 3/24/16
Michael Wagman 3/24/16
Monica Wait 3/24/16

Through: Mark Corbin, Branch Chief
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Mark Corbin 3-24-16

Prior to conducting this refined Endangered Species Assessment, the Environmental Fate and Effects Division (EFED) performed a screening level ecological risk assessment for a Federal action involving proposed new uses of the diglycolamine salt of dicamba (dicamba DGA) on dicamba herbicide-tolerant soybean on March 8, 2011 (DP 378444); an amendment to the assessment was issued on May 20, 2014 (DP 404138, 404806, 405887, 410802, and 411382). Concurrent with this refined Endangered Species Assessment, a Section 3 New Use dicamba DGA salt on dicamba-tolerant cotton screening-level assessment (DP 404823) and a subsequent addendum (DP 426789) that addresses multiple issues (spray drift buffers, runoff, risk to terrestrial invertebrates and updated mammalian toxicological endpoints for parent dicamba and its degradate, DCSA) have been finalized. In the screening level risk assessment, potential direct risk concerns could not be excluded for:

- mammals (chronic, from the soybean use only, due to residues from dicamba's metabolite, DCSA, rather than from parent dicamba);
- birds (acute from parent dicamba for both soybean and cotton uses; chronic from DCSA residues only in soybean but not in cotton), considered surrogates for reptiles, and terrestrial-phase amphibians; and
- terrestrial plants (soybean and cotton uses)

In the screening level risk assessments, indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Additionally, the screening level assessment showed that direct risk concerns were unlikely (*i.e.* levels of concern were not exceeded) for:

- mammals (acute) and (chronic—for the cotton use only);
- birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton);
- terrestrial insects (acute and chronic);
- freshwater fish (acute and chronic);
- aquatic-phase amphibians (acute and chronic);
- estuarine/marine fish (acute and chronic);
- freshwater invertebrates (acute and chronic); estuarine/marine invertebrates (acute and chronic); and
- aquatic plants¹

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that

¹ The listed species LOC was exceeded for non-vascular aquatic plants, however there are no listed species of this taxa.

includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations. At each screening step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still exceeds the Agency’s levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. When a given taxonomic RQ exceeds either the acute or chronic LOC a concern for direct toxic effects is identified for that particular taxon. If RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

The purpose of this document is to explain the refined risk assessment conducted for Federally-listed threatened or endangered (listed) species that could potentially be impacted by this pesticide registration. The refined assessment was conducted based on the 2004 Overview document, as discussed above. The assessment of risks to listed species posed by the use of Dicamba DGA has been conducted in phases covering a specific set of states, assessing risk to all the listed species covered in those states. This assessment covers the endangered species analysis for 11 states: Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia (AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV). Based on EFED’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), 322 species in the 11 states proposed for registration were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant soybean and cotton uses. **Table 1** below presents a

summary of this assessment. Separate concurrent assessment phases cover the endangered species analysis for 16 states (Arkansas, Kansas, Louisiana, Illinois, Indiana, Iowa, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin (DP 416416, 420160, 420159, 420352, 421434, 421723)) and 7 states (Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas (DP 422305)).

EPA consulted U.S. Fish and Wildlife Service Recovery Plans to determine whether listed species in these states would be expected to occur in an action area encompassing the treated soybean and corn fields. The refined assessment was then conducted on those species that could not be excluded from the action area. EPA also consulted the recovery plans in the refined assessment for additional habitat information and incorporated species biological information regarding dietary items (used to model dicamba DGA residues in prey tissue) and body weight (used to determine food consumption rates and scale ecotoxicity data from the tested surrogate species, the bobwhite quail and rat, to the body weight of the listed species).

The Environmental Fate and Effects Division (EFED) has completed an endangered species risk assessment for Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia in support of registering dicamba diglycolamine (DGA) salt on herbicide-tolerant cotton and soybean in these states. **Table 1** presents a summary of the assessment.

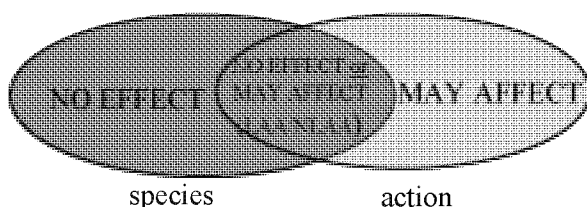
Table 1. Summary of species effects determinations and critical habitat modification determinations for Federally listed threatened or endangered species in Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia for dicamba DGA use on genetically modified cotton and soybeans.

Species	Effects Determination	Comments
Audubon Crested Caracara	May Affect, Not Likely to Adversely Affect for Palm Beach County (Cotton only; concurrence by USFWS pending) No effect (soybean; and for cotton in all other counties except Palm Beach)	The species is found in 22 counties in Florida. However, no county has soybean production and only one county has any cotton: Palm Beach County
All other species (terrestrial and aquatic)	No effect	
Critical Habitat	Modification Determination	Comments
All Critical Habitats (322 species)	No Modification	None

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY AFFECT (LIKELY or NOT LIKELY TO ADVERSELY AFFECT) categories depending upon their specific biological needs, circumstances of exposure, etc.



- LIKELY or NOT LIKELY TO ADVERSELY AFFECT determinations are made using the following criteria:
 - Insignificant - The level of the effect cannot be meaningfully related to a “take.”
 - Highly Uncertain - The effect is highly unlikely to occur.
 - Wholly beneficial - The effects are only good things.

Spray Drift Mitigation

EFED's refined endangered species risk assessment took into account the spray drift mitigation language that was added to the most recent proposed label submitted by the registrant. An accounting of federally-listed threatened or endangered species within the 11 states (covered in this assessment) proposed for dicamba DGA use on genetically modified cotton and soybeans is included in **Appendix 1** (322 species). Specifically, the spray drift mitigation language on the M1691 Herbicide Supplemental labels for the use dicamba DGA salt on ROUNDUP READY 2 XTEND™ soybean and BOLLGARD II® XTENDFLEX cotton includes the following limitations:

Specifically, the spray drift mitigation language includes the following limitations:

- Specifying the use of a nozzle (Tee Jet® TTI11004) with ASABE S-572 ultra-coarse and extremely coarse droplet spectra and a maximum operating pressure of 63 psi.

- A maximum equipment ground speed of 15 miles per hour and ground boom height of 24 inches above the target pest or crop canopy.
- Restricting all applications when wind speeds are < 3 mph or > 15 mph and restricting applications when wind is blowing towards sensitive areas at > 10 mph. Maintaining use of a 110 foot in-field buffer for a 0.5 lb a.i./A application (220 foot in-field buffer for a 1 lb a.i./A application) when the wind is blowing towards any areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures.
- Applications done in low relative humidity conditions are to use equipment set to produce larger droplet spectra to compensate for evaporation.
- Applications are not be conducted during temperature inversions.
- In order to prevent effects to non-target susceptible plants, the label also includes the following language: “do not apply under circumstances where spray drift may occur to food, forage or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants because severe injury or destruction may result, including plants in a greenhouse. Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from the off-target movement of M1691 Herbicide. The Applicator must survey the application site for neighboring sensitive areas prior to application. The applicator also should consult sensitive crop registries for locating sensitive areas where available.”
- Finally, in order to prevent unintended damage from the drift of M1691 Herbicide, the label says not to apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

The incorporation of the spray drift mitigation measures into the product labeling as outlined above would result in exposure to dicamba DGA from spray drift at a level where effects are expected only within the confines of the treated field and so the action area is limited to the dicamba DGA treated field. Further, the incorporation of the “susceptible plants” spray drift mitigation language on the label is to avoid damage to these plants (including adjacent crops). Because the risk assessment interprets the threshold for plant damage concern to be based on the most sensitive plant species tested and the screening level ecological risk assessment has demonstrated that these plant effects endpoints constitute the most conservative terrestrial organism levels of effect, it is concluded that the “susceptible plants” requirement requires a level of drift mitigation that would also prevent less sensitive organisms from being exposed at levels of concern. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to dicamba DGA, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any effects thresholds of concern. Additionally, as indicated in the screening level ecological risk assessments for cotton and soybean, no aquatic receptor taxa are of concern for drift or runoff exposure (LOCs were not exceeded for aquatic taxa). **Consequently, all but 14 of the 322 listed species originally identified as potentially at-risk are determined to be**

given a “no effect” (NE) without further refinement because they are not expected to occur in an action area encompassing the treated soybean and cotton fields (Appendix 2). The remaining 14 species are assessed using the refinements set forth in the 2004 Overview document referred to earlier in this assessment and considering the restrictions contained in the proposed labeling, species specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment.

Exposure through Runoff

The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted concentrations from modeling were lower than the most sensitive taxa’s endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would also protect against the risk of exposure to listed species off the treated field.

In addition to the spray drift and runoff mitigation measures contained in the proposed labeling, EFED analyzed species-specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment. An accounting of the federally-listed threatened or endangered species within the 11 states proposed for this registration showed 322 listed species as potentially at risk (direct or indirect effects) as a result of the screening-level assessment (**Appendix 1**). The spray drift mitigation label language cannot preclude listed species being exposed to dicamba DGA salt or DCSA residues on treated fields, should a listed species utilize such areas as part of its range and corresponding habitat. Of the 322 listed species within the 11 states (AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV) considered part of the proposed Federal decision, the following 14 species were reasonably expected to occur on soybean and cotton fields, which could potentially be treated with dicamba and therefore could not be assumed to be “no effect” solely on the basis of occurrence outside the action area:

Of these 14 species, a “no effect” determination was reached in the concurrent assessment actions for 16 states (DP 416416, 420160, 420159, 420352, 421434, 421723 covering AR, IL, IA, IN, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI) and 7 states (DP 422305 covering AL, GA, KY, MI, NC, SC, and TX) for the following species and is applicable to these 11 states as well:

- Eastern indigo snake (*Drymarchon corais couperi*)
- Indiana bat (*Myotis sodalis*)
- Lesser prairie-chicken (*Tympanuchus pallidicinctus*)
- Virginia big-eared bat (*Corynorhinus (=Plecotus) townsendii virginianus*)

- Ocelot (*Leopardus (Felis) pardalis*)
- Whooping crane (*Grus americana*)
- Red wolf (*Canis rufus*)
- Gray wolf (*Canis lupus*)

This leaves the following species for which the remainder of this document uses species specific biological information and dicamba DGA use patterns in more depth to further refine the assessment and effects determinations:

- California condor (*Gymnogyps californianus*)
- Audubon's crested caracara (*Polyborus plancus audubonii*)
- Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*)
- Jaguar (*Panthera onca*)
- Florida panther (*Puma (=felis) concolor coryi*)
- Sonoran pronghorn (*Antilocapra americana sonoriensis*)

Therefore, species specific biological information (e.g., body size, dietary requirements, and seasonality) and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations.

This assessment also uses the refined exposure values determined in the cotton screening level assessment and the concurrently issued addendum to the soybean screening level risk assessment documents compared to the initial exposure estimates from the soybean screening level assessment. This ESA assessment also evaluates chronic exposures from DCSA separately from the chronic exposure to parent dicamba. Dicamba exposure values were determined from the upper bound of the modeled T-REX run for exposures following spray applications based on the Kenaga nomogram modified by Fletcher *et al* (1984), which is based on a large set of actual field residue data. Modeled dicamba exposure values were identical between the soybean addendum and the cotton screening level risk assessment (since the maximum application rates and minimum application intervals are the same).

Similar modeling of DCSA residues, which are formed inside the tolerant-soybean and tolerant-cotton plants through plant metabolism, is not feasible at this time due to a lack of sufficient data tracking DCSA residues in plant tissues over time to ascertain degradation rates. Therefore, in the soybean addendum and the cotton screening-level risk assessment, EFED used the maximum empirical measured DCSA residue concentrations in dicamba-tolerant soybean (61.1 mg/kg (ppm) DCSA in broadleaf plants and 0.440 ppm in soybean seeds) and cotton plant tissues (6.29 ppm DCSA in cotton gin byproducts and 0.27 ppm in undelinted cotton seed) to evaluate chronic exposures to DCSA for animals foraging on soybean and cotton plants. Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed soybean/cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications (*i.e.* arthropod concentrations estimated to be approximately 70% of the concentrations in broadleaf plant tissues or 42.5 ppm

DCSA in arthropods feeding on soybean plants and 4.4 ppm in arthropods feeding on cotton plants). The empirical residue data for cotton indicated that chronic exposures of birds and mammals to dicamba or DCSA in cotton tissues *would not* be above any levels of concern. Although the concurrently issued soybean addendum indicates that chronic risk to mammals and birds was only a concern from DCSA residues in plant/prey tissues and not from residues of parent dicamba, since the original soybean screening-level assessment (USEPA, 2011) indicated chronic risk to mammals, this assessment presents the estimated exposures and comparisons to threshold toxicity values for both dicamba and DCSA for mammals, but evaluates them separately since their chronic toxicity and exposure profiles differ greatly. For birds, following the conclusions of the screening level assessments and the soybean addendum, only acute risk from dicamba exposures and chronic risk from DCSA exposures is evaluated.

The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Refined ecological risk assessment for the remaining species potentially exposed to dicamba residues

For the effects determinations for California condor, Audobon's crested caracara, Delmarva Peninsula fox squirrel, jaguar, Florida panther and Sonoran pronghorn, a refined risk assessment approach was used to evaluate additional lines of evidence to determine whether the conservative generic assumptions in the screening risk assessment apply to a particular species of interest (e.g. the California condor). In the case of the California condor, the refined risk assessment investigated the impacts of more condor-specific data related to:

1. Bird size (as the condor is larger than the 1000g large bird category used in the initial screen)
- 2.. Bird food consumption tailored to:
 - a. The true weight of the bird
 - b. Energy requirements of the condor
 - c. Improvement on the generic food intake model of the screen to assess energy content of the diet and the actual free living energy requirements of a bird the size of a California condor
3. Toxicity endpoints scaled from the weight of the tested surrogate species (bobwhite quail) to reflect the comparatively larger actual size of the condor.

Using the California condor as the example to show how EPA made its effects determinations, EPA determined that the California condor could be primarily feeding on carcasses of large mammals that may have been present in treated cotton and soybean fields. EPA therefore assumed that the predicted concentrations of dicamba DGA salt found in large (1000g) mammals that were exclusively feeding on short grass exposed to dicamba residues from the spray application would be a conservative prey analysis for the condor consistent with the preliminary risk concerns identified in the screening assessments. For chronic exposures to DCSA residues, EPA assumed the prey mammal was feeding exclusively on soybean forage containing the

maximum measured DCSA concentrations. This analysis is conservative as it assumes 1) that 100% of the condor's food consumption comes from 1kg mammals that have fed exclusively on dicamba exposed short grass (the dietary item with the highest modeled residue levels) or DCSA residues in exposed dicamba-tolerant soybean plants (the only plants that would have significant DCSA residues) and 2) the level of dicamba DGA residues assumed to be on the consumed short grass is based on the upper bound Kenaga residues expected for short grass directly exposed to spray applications of dicamba DGA while the level of DCSA residues is assumed to be the maximum measured concentration (61.1 ppm). Additionally, using the residues in a 1 kg mammal carcass is also likely conservative, given that condor primarily feeds on larger prey species such as deer, elk, feral pigs, livestock, horses, and pinnipeds. EPA determined the field metabolic rate of the California condor through the use of a published peer reviewed allometric equation that relates bodyweight to energy requirements. Values were obtained from a published peer reviewed EPA document produced by the Office of Research and Development for Agency-wide use in conducting ecological risk assessment (USEPA, 1993) and the work of Dunning, 1984. The mass of dicamba DGA in the mammalian prey diet is determined from the T-REX run found in the addendum to the screening-level risk assessment (USEPA, 2016a), issued concurrently with this refined risk assessment. The mass of prey consumed per day is then multiplied by mass of dicamba in the mammal's diet to determine the mass of dicamba or DCSA in the condor's daily diet in mg/day. Then the daily dose that the condor (considering its bodyweight) receives is determined by multiplying the mass of dicamba or DCSA in the exposed mammalian prey (which had consumed exclusively exposed plants) divided by the bodyweight of the condor. Then EPA scaled the acute toxicity endpoint (based on the tested surrogate bird species, bobwhite quail's default weight of 178 grams) to the bodyweight of the California condor to determine the acute oral toxicity for the condor. For exposures to DCSA residues, the chronic toxicity endpoint for the mallard (the most sensitive tested species) was modified by the relationship between the chronic dicamba and DCSA endpoints for rats (a 17x difference). The acute RQ for dicamba exposures is then calculated by dividing the daily dose of dicamba from consuming the exposed mammal carcasses by the acute oral toxicity endpoint while the chronic RQ is calculated by dividing the daily dose of DCSA by the chronic toxicity endpoint. In this case, the acute RQ was 0.01, which is below the endangered species level of concern of 0.1 while the chronic RQ was 0.02 which is below the listed and non-listed species chronic LO of 1.0. At this point, EPA was able to conclude that dicamba DGA would not have an effect on the California condor.

Birds

The screening-level assessments showed that birds could be at risk of mortality from acute exposures to dicamba DGA on treated fields, but chronic risk was not expected as no chronic RQs exceeded the Agency's LOC (1.0) for chronic risk (USEPA 2011. D378444, p. 15). The concurrently issued soybean addendum did indicate that chronic exposures to DCSA residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, for listed species that could reasonably be expected to occur on treated soybean and cotton fields, EPA conducted a refined assessment for acute (dicamba only) and chronic (DCSA only, and only for soybean) exposures. Of the remaining bird species identified as potentially at acute risk in the seven states, two are reasonably expected to occur on treated soybean and cotton

fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

California condor

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds showed concerns for acute effects. The species' 5-Year review (USFWS, 2013) describes the condor as an obligate scavenger feeding primarily on large mammalian carcasses including deer, elk, feral pigs, livestock, horses, and pinnipeds, though smaller carrion may also be consumed. The assumptions in the initial screen were adjusted to account for the condor's biology:

The first step in the refinement process is to calculate dicamba DGA residues in the prey species. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, EFED calculated the residues in this prey as 40.17 mg dicamba DGA salt/kg-bw (T-REX modeling from concurrently issued dicamba soybean addendum).

The next step is to calculate the expected daily dose for a typical 10 kg (10000 g, Dunning 1984) condor, the adjusted LD₅₀ value, and the acute dose-based RQ for the condor based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.301(10000)^{0.75})/(1-0.69)/1000 = 0.97 \text{ kg wet/day}$$

$$\begin{aligned} \text{Dose-based EEC in condor eating large mammal} &= 40.17 \text{ mg/kg wet} \times 0.97/(10000/1000) \\ &= \mathbf{3.90 \text{ mg/kg-bw/day}} \end{aligned}$$

$$\text{Adjusted LD}_{50} = 188 \text{ mg/kg-bw} (10000/178)^{(1.15-1)} = \mathbf{344 \text{ mg/kw-bw}}$$

$$\text{Acute Dose-Based RQ} = 3.90/344 = \mathbf{0.01}$$

An RQ of 0.01 does not exceed the LOC of 0.1; **consequently a “no effect” determination is concluded for the California condor.**

DCSA Assessment for California condor consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

$$1000 \text{ g mammal prey ingestion rate (dry)} = 0.621(1000)^{0.564} = 30.56 \text{ g /day}$$

$$1000 \text{ g mammal prey ingestion rate (wet)} = 30.56/0.2 = 152.8 \text{ g/day}$$

$$\text{DCSA residue in prey eating soybean forage/hay } 61.1 \text{ mg DCSA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{9.34 \text{ mg/kg-bw/day}}$$

The next step is to calculate the expected daily dose for a typical 10 kg (10000 g, Dunning 1984) condor, the adjusted LD₅₀ value, and the acute dose-based RQ for the condor based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.301(10000)^{0.75})/(1-0.69)/1000 = 0.97 \text{ kg wet/day}$$

$$\text{Dose-based EEC in condor eating large mammal} = 9.34 \text{ mg/kg wet} \times 0.97/(10000/1000) = \mathbf{0.91 \text{ mg/kg-bw/day}}$$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

$$\text{Chronic Dose-Based RQ} = 0.91/40.88 = \mathbf{0.02}$$

Audubon's Crested Caracara

Dicamba Acute Effects Assessment

The five year review (USFWS 2009) of the caracara indicated that current habitat use includes (ranked highest to lowest proportion): improved pasture, dry prairie, freshwater marsh, mixed upland hardwoods, shrub swamp, shrub and brushland, grassland, pinelands, bare soil, urban, other agriculture, citrus, and scrub. It is therefore considered likely that individual birds may make use of cultivated soybean and cotton fields as potential foraging habitat.

Initial screening level risk assessment results for birds indicated concerns for acute effects. The assumptions in the initial screen were adjusted to account for the caracara's biology:

The first step in the refinement process is to calculate dicamba DGA residues in the prey species. The caracara is an opportunistic predator of a variety of terrestrial vertebrates and invertebrates (USFWS 1999). In evaluating dicamba residues from the screening risk assessment, the residues for a small bird consuming short grass exceed those of other dietary items (such as arthropods) and so conservatively serve as a dietary exposure pathway for this species-specific risk assessment, and EFED calculates the residues as 299.47 mg DGA/kg-bw (T-REX modeling from concurrently issued dicamba soybean addendum). This is a conservative approach as it assumes that the caracara is feeding exclusively on a prey species represented by a small (20g) bird feeding exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba.

The next step is to calculate the expected daily dose for a typical 900g (Dunning 1984) bird, the adjusted LD₅₀ value, and the acute dose-based RQ for the caracara based on the following allometric equations:

Field metabolic rate kcal/day = $1.146(900)^{0.749} = 187$ kcal/day (USEPA 1993, body weight Dunning 1984).

Mass of prey consumed per day = $187 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.78 \text{ AE}) = 141 \text{ g/day}$ (1.7 is energy content of prey item from USEPA (1993); 0.78 is assimilation efficiency from USEPA 1993, assumption of small mammal prey from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of dicamba DGA in 20 g small bird diet item = 299.47 mg/kg-ww from T-REX run

Mass of dicamba in daily diet = $141 \text{ g/day} \times 299.47 \text{ mg dicamba/kg-ww small bird prey} \times 0.001 = 42.23 \text{ mg/day}$

Daily dose in caracara = $42.23 \text{ dicamba/day} / 0.9 = \mathbf{46.92 \text{ mg/kg-bw/day}}$

Adjusted LD₅₀ = $188 \text{ mg/kg-bw} (900/178)^{(1.15-1)} = \mathbf{239.74 \text{ mg/kg-bw}}$

Acute Dose-Based RQ = $46.92/239.74 = \mathbf{0.20}$

An RQ of 0.20 exceeds the LOC of 0.1, suggesting that even at a more refined level of assessment for this species an effect is possible should the species be found in treated fields. Similar though lower RQs would follow for consumption of small mammals (screening assessment dicamba residue 250.70 mg/kg, but not for the more likely insect diet during preplant with screening assessment residues of 102.99 mg/kg).

The analysis suggests that if a caracara is feeding in a cotton or soybean field, then there is a potential for a lethal event. Establishing a potential for overlap between species range and the cropped areas proposed for treatment is an important consideration in how likely an exposure event might be for individual caracara. To evaluate overlap between cotton or soybean and a specific species range, a GIS co-occurrence analysis was conducted. The caracara's range was compared to the aggregated National Agricultural Statistics Service (NASS) reported acres from the 2012 Census of Agriculture Full Report, and the 5 year aggregated USDA Cropland Data Layer (CDL) crop group layers. The most recent species range file provided by U.S Fish and Wildlife Service headquarters office, as of May 26, 2015, was used for these analyses.

To calculate the NASS overlap, first all the reported crops from the 2012 Census of Agriculture Full Report were cross walked into the 11 EFED crop groups for each county. All counties within the species range were selected from the aggregated crop group table, each crop was summed to generate the total NASS acres, and then percent overlap was calculated.

The CDL is the best available land cover data to spatially characterize agricultural crops nationally. As with any land cover data, there will be errors present. The accuracy of the CDL is well documented on a state by state basis. Essentially, major commodity crops have a more robust training and validation dataset than minor crops, and their accuracy values correspond accordingly. Several methods have been employed to minimize data errors within the CDL.

The CDL has over 100 cultivated classes hierarchically grouped into 11 general classes. Combining classes reduces errors of omission and commission between similar crop categories. The CDL is also annually produced. Five years of CDL from 2010-2014 were temporally aggregated. The concept is that anywhere a class occurs within those 5 years is represented as a temporally aggregated individual class. Temporal aggregation also accounts for crop rotations.

The CDL's agricultural classes were further refined by comparing county level NASS 2012 Census of Agriculture (CoA) acreage reports to county level CDL acreages. If a county's CDL acreage for a given class was lower than the CoA, EPA expanded the CDL class's extent within cultivated areas until the CDL acreage matched the CoA acreage. Using the temporally and thematically aggregated CDL as an input, EPA developed a script that compares each CDL crop group in each county to the corresponding CoA acreage report. If the CDL acreage was less than NASS, EPA expanded the raster in 1 pixel iterations until the CoA value was reached, or the area within the county's cultivated mask was built out. Region growing was restricted using the most recent CDL Cultivated Layer as a mask, so as to avoid buffering into any non-agricultural land cover types. This method reduces land cover mapping errors by adjusting the extent of each category to the best available census values.

To calculate the overlap of the 5-year CDL-aggregated layers, the zonal statistics tool in ArcGIS was used to count the pixels for each layer within the species range. These counts were converted to an area measurement, and the percent overlap calculated. The intersection of the maps represents the geographical extent of overlap of caracara habitat with cotton and soybeans. None of the Audubon's crested caracara's range overlaps with soybean using either the NASS or CDL datasets. Using the NASS dataset, none of the caracara's range overlaps with cotton production while using the CDL dataset <0.00001% of the established range overlaps with cotton (1 acre cotton coverage overlap within the caracara's habitat in Palm Beach County). As the crop overlap analysis suggests no soybean cropland co-occurrence with caracara range, EPA **concludes a No Effect (NE) determination for the soybean use.**

On the basis of the extremely low identified proportion of the distribution of the species, the co-occurrence of the species with treated cotton is determined to not occur in the majority of the caracara range (<0.00001%), and to be highly unlikely to occur in the one county with any cotton acreage (Palm Beach County with 1 acre of cotton according to the CDL dataset).

Consequently, if the dicamba cotton label does not restrict Palm Beach County, EPA would conclude a May Affect/Not Likely to Adversely Affect (NLAA) determination for the Audubon's Crested Caracara with Palm Beach County (concurrence pending) while a No Effect (NE) determination would be concluded for the other counties in the caracara's

range. If use in Palm Beach County was excluded on the cotton label, than EPA would also conclude a No Effect determination for the cotton use.

DCSA Assessment for Audubon caracara

Given the acute analysis for parent dicamba DGA and the conclusion of a No effect or May Affect/Not Likely to Adversely Affect determination based on a lack of co-occurrence of the caracara with soybean and cotton production outside of Palm Beach County and extremely low co-occurrence in Palm Beach County, further analysis was deemed unnecessary for the DCSA degrade effects to the caracara.

Mammals

The screening-level assessments indicated that acute risk to mammals was not expected as no acute RQs exceeded the Agency's LOC (0.1) for acute risk (USEPA 2011. D378444, p. 15). However, the soybean screening-level assessment (USEPA, 2011) indicated that mammals could be at reproductive risk from chronic exposures to dicamba DGA on treated fields, though the cotton screening level and concurrently issued soybean addendum (USEPA, 2016a and USEPA, 2016b) indicated that chronic exposures to dicamba DGA would be below the chronic LOC (1.0). This difference is due to soybean screening level risk assessment's use of a chronic endpoint from the rat 2-generation study (MRID 43137101), of 45 mg/kg-bw for the NOAEL, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016c; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, as pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. Therefore, the cotton screening level risk assessment, the concurrently issued soybean addendum and this refined endangered species risk assessment use this revised NOAEL for dicamba DGA salt.

The concurrently issued soybean addendum did indicate that chronic exposures to dicamba's metabolite, DCSA, residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, EPA only conducted a refined assessment for chronic exposures to DCSA in soybeans for listed species that could reasonably be expected to occur on treated soybean fields.

Of the mammalian species identified as potentially at risk in the eleven states, four are reasonably expected to occur on treated soybean fields. Species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for the four species potentially expected to occur on treated soybean fields.

Delmarva Peninsula fox squirrel

Dicamba Chronic Effects Assessment

The recovery plan for the squirrel (USFWS 1993; http://ecos.fws.gov/docs/recovery_plan/930608.pdf) discusses a number of food items for the organism, however much of the discussion centers on forest habitat and its resources. The document does mention the squirrel's association with woodlands proximal to corn and soybean fields. Corn, soybean, and other grains provide reliable supplemental food according to Sheperd and Swihart (1995). However, it is unlikely, given the toxic gossypol content of cotton seed, that the plant provides similar resources as soybean for the squirrel. The following represents a refined risk assessment considering the body mass associated energy requirements of the squirrel and the use of soybeans as a food source.

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Using the conservative assumption that 100% of the fox squirrel's diet is made up of exposed soybean seed/grain having received the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for fox squirrel's biology:

Field metabolic rate kcal/day = $2.514(800)^{0.507} = 74.51$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the fox squirrel from Recovery Plan (USFWS 1993; http://ecos.fws.gov/docs/recovery_plan/930608.pdf))

Mass of soybean seed consumed per day = $74.51 \text{ kcal/day} / (5 \text{ kcal/g ww} \times 0.85 \text{ AE}) = 17.5$ g/day
(5 is energy content of seed item from USEPA (1993); 0.85 is assimilation efficiency for seeds consumed by rodents from USEPA 1993)

Mass of dicamba DGA in seed/grain diet 17.74 mg/kg-ww from T-REX run
(conservative estimate of exposure for the fox squirrel's diet of tree mast, buds, flowers, insects, fruit, seeds etc. and available dietary items in agricultural fields).

Mass of dicamba DGA in daily diet = $17.5 \text{ g/day} \times 16.43 \text{ mg dicamba DGA/kg-ww seed} \times 0.001 = 0.29$ mg/day

Daily dose in fox squirrel = $0.29 \text{ mg dicamba DGA/day} / 0.8 \text{ kg} = 0.36 \text{ mg/kg-bw/day}$

Fox squirrel NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} (350/800)^{(0.25)} = 110.61 \text{ mg/kg-bw}$

The RQ for chronic effects = $0.36/110.61 = 0.003$

A chronic RQ of 0.003 does not exceed the chronic LOC of 1.0. **Consequently, it is reasonable to make a "no effect" determination for the Delmarva Peninsula fox squirrel.**

DCSA Analysis for Delmarva Fox Squirrel consuming DCSA residues present in soybean grain

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Using the conservative assumption that 100% of the fox squirrel's diet is made up of exposed soybean seed/grain having containing the maximum measured DCSA residues, exposure assumptions from the screening assessment were adjusted to account for fox squirrel's biology:

Field metabolic rate kcal/day = $2.514(800)^{0.507} = 74.51$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the fox squirrel from Recovery Plan (USFWS 1993; http://ecos.fws.gov/docs/recovery_plan/930608.pdf))

Mass of soybean seed/grain consumed per day = $74.51 \text{ kcal/day} / (5 \text{ kcal/g ww} \times 0.85 \text{ AE}) = 17.5$ g/day
(5 is energy content of seed item from USEPA (1993); 0.85 is assimilation efficiency for seeds consumed by rodents from USEPA 1993)

Mass of DCSA in seed/grain diet 0.44 mg/kg-ww (maximum empirical residues for the most likely available dietary items (soybean grain) in agricultural fields).

Mass of DCSA in daily diet = $17.5 \text{ g/day} \times 0.44 \text{ mg DCSA/kg-ww seed} \times 0.001 = 0.008$ mg/day

Daily dose in fox squirrel = $0.008 \text{ mg DCSA /day} / 0.8 \text{ kg} = \mathbf{0.01 \text{ mg/kg-bw/day}}$

Fox squirrel NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} (350/800)^{(0.25)} = \mathbf{6.51 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.01/6.51 = \mathbf{0.001}$

An chronic RQ of 0.001 does not exceed the chronic LOC of 1.0. **Consequently, it is reasonable to make a “no effect” determination for the Delmarva Peninsula fox squirrel.**

Jaguar

Dicamba Chronic Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Jaguars are ambush hunters with large home ranges, capable of feeding on a wide variety of prey, though medium-sized (1-10 kg) and larger prey appear to be much more commonly used than smaller prey species (USFWS, 2012, Rosas-Rosas, 2006 and López-González and Miller, 2002). Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the

upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the jaguar's biology:

Field metabolic rate kcal/day = $0.6167(45000)^{0.862} = 6326$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguar from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of prey consumed per day = $6326 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 4430$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of dicamba DGA in 1 kg mammal diet 40.17 mg/kg-ww (conservative estimate for a 1 kg mammal feeding on short grass) from T-REX run

Mass of dicamba DGA in daily diet = $4430 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 178$ mg/day

Daily dose in jaguar = $178 \text{ mg dicamba DGA/day} / 45 \text{ kg} = \mathbf{3.95 \text{ mg/kg-bw/day}}$

Jaguar NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/45000)^{(0.25)} = \mathbf{40.39 \text{ mg/kg-bw}}$

The RQ for chronic effects = $3.95/40.39 = 0.10$.

A chronic RQ of 0.10 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the jaguar.**

DCSA Assessment for Jaguar consuming prey that had previously consumed exposed soybean forage

Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed soybean forage containing the maximum measured DCSA residues (61.1 mg/kg), exposure assumptions from the screening assessment were adjusted to account for the jaguar's biology:

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56$ g /day

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 45 kg jaguar, the adjusted NOAEL value and the chronic dose-based RQ for the jaguar based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(45000)^{0.862} = 6326$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguar from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of prey consumed per day = $6326 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 4430$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of DCSA in 1 kg mammal diet = 9.34 mg/kg-ww (conservative estimate for a 1 kg mammal feeding on soybean forage containing the maximum measured empirical residues of 61.1 mg/kg)

Mass of DCSA in daily diet = $4430 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 41.38$ mg/day

Daily dose in jaguar = $41.38 \text{ mg DCSA/day} / 45 \text{ kg} = \mathbf{0.92 \text{ mg/kg-bw/day}}$

Jaguar NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} \times (350/45000)^{(0.25)} = \mathbf{2.38 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.92/2.38 = 0.39$

A chronic RQ of 0.39 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the jaguar.**

Florida Panther

Dicamba Chronic Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects. The recovery plan (USFWS, 2008) describes the panther as a wide ranging animal primarily feeding on white-tailed deer and feral hogs with secondary prey including raccoon, armadillos, rabbits and alligators. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the panther's biology:

Field metabolic rate kcal/day = $0.6167(34000)^{0.862} = 4968$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the typical panther female from Recovery Plan, USFWS 2008)

Mass of prey consumed per day = $4968 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 3479 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2008)

Mass of dicamba DGA in 1 kg mammal diet 40.17 (conservative estimate for a 1kg mammal feeding on short grass) mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $3479 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 139.75 \text{ mg/day}$

Daily dose in panther = $139.75 \text{ mg dicamba DGA /day} / 34 \text{ kg} = 4.11 \text{ mg/kg-bw/day}$

Panther NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/34000)^{(0.25)} = 43.32 \text{ mg/kg-bw}$

The RQ for chronic effects = $4.11/43.32 = 0.09$

A chronic RQ of 0.09 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the panther.**

DCSA Assessment for Florida panther consuming prey that had consumed exposed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56 \text{ g /day}$

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 34 kg panther, the adjusted NOAEL value and the chronic dose-based RQ for the panther based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(34000)^{0.862} = 4968$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the typical panther female from Recovery Plan, USFWS 2008)

Mass of prey consumed per day = $4968 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 3479$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2008)

Mass of DCSA in 1 kg mammal diet 9.34 (conservative estimate for a 1kg mammal feeding on soybean forage containing the maximum measured empirical residues of 61.1 mg/kg-ww)

Mass of DCSA in daily diet = $3479 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 32.49$ mg/day

Daily dose in panther = $32.49 \text{ mg DCSA /day} / 34 \text{ kg} = \mathbf{0.96 \text{ mg/kg-bw/day}}$

Panther NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} \times (350/34000)^{(0.25)} = \mathbf{2.55 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.96/2.55 = 0.38$

A chronic RQ of 0.38 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the panther.**

Sonoran pronghorn

Dicamba Chronic Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Pronghorn consume forbs such as buckwheat, ragweed, milkvetch and borage species as well as some woody species including ironwood and mesquite and succulent fruit such as chain-fruit cholla (USFWS, 2015). Though many agricultural crops do not provide adequate forage for the pronghorn, some, such as alfalfa do (USFWS, 2015). Therefore, it is possible that pronghorn

may forage on agricultural crops such as soybean. Given the toxic gossypol content of cotton plant parts, it is unlikely that this plant provides similar resources as soybean for the pronghorn. Using the conservative assumptions that the pronghorn is exclusively consuming exposed broadleaf plants (the most likely dietary item with the highest modeled dicamba residues) receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the pronghorn's biology:

Field metabolic rate kcal/day = $1.419(47630)^{0.727} = 3571$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the pronghorn from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of broadleaf plants consumed per day = $3571 \text{ kcal/day} / (0.63 \text{ kcal/g ww} \times 0.76 \text{ AE}) = 7458 \text{ g/day}$ (0.63 is energy content of broadleaf dietary item from USEPA (1993); 0.76 is assimilation efficiency from USEPA 1993, broadleaf plant diet from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of dicamba DGA in broadleaf plant diet 147.91 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $7458 \text{ g/day} \times 147.91 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 1103 \text{ mg/day}$

Daily dose in pronghorn = $1103 \text{ mg dicamba DGA/day} / 47.63 = \mathbf{23.16 \text{ mg/kg-bw/day}}$

Pronghorn NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/47630)^{(0.25)} = \mathbf{39.82 \text{ mg/kg-bw}}$

The RQ for chronic effects = $23.16/39.82 = 0.58$.

A chronic RQ of 0.58 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the pronghorn.**

DCSA Analysis for Pronghorn

Using the conservative assumptions that the pronghorn is exclusively consuming exposed soybean plants containing the maximum measured DCSA residues (61.1 mg/kg), exposure assumptions from the screening assessment were adjusted to account for the pronghorn's biology:

Field metabolic rate kcal/day = $1.419(47630)^{0.727} = 3571$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the pronghorn from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of soybean forage consumed per day = $3571 \text{ kcal/day} / (0.63 \text{ kcal/g ww} \times 0.76 \text{ AE}) = 7458 \text{ g/day}$ (0.63 is energy content of broadleaf dietary item from USEPA (1993); 0.76 is assimilation efficiency from USEPA 1993, broadleaf plant diet from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of DCSA in broadleaf plant diet 61.1 mg/kg-ww (maximum measured concentrations in soybean forage)

Mass of DCSA in daily diet = $7458 \text{ g/day} \times 61.1 \text{ mg DCSA/kg-ww soybean forage} \times 0.001 = 455.68 \text{ mg/day}$

Daily dose in pronghorn = $455.68 \text{ mg dicamba DGA/day} / 47.63 = \mathbf{9.57 \text{ mg/kg-bw/day}}$

Pronghorn NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} \times (350/47630)^{(0.25)} = \mathbf{2.34 \text{ mg/kg-bw}}$

The RQ for chronic effects = $9.57/2.34 = \mathbf{4.09}$

A chronic RQ of 4.09 exceeds the chronic LOC of 1.0, suggesting that an effect is possible should the species be found in treated soybean fields (There were no exceedances for mammals feeding on DCSA contaminated cotton tissues based on the Section 3 screening level risk assessment. However, similar calculations conducted for pronghorn feeding in cotton fields would result in an RQ of 0.42, based on the maximum measured DCSA residues in cotton. As this would be below the LOC, a “**no effect**” (NE) determination could be made for pronghorn feeding on cotton fields)

This analysis suggests that if a pronghorn is feeding in a soybean field there is a potential for a lethal event. Establishing a potential for overlap between species range and the cropped areas proposed for treatment is an important consideration in how likely an exposure event might be for individual pronghorn.

To evaluate overlap between cotton and soybean and a specific species range a GIS co-occurrence analysis was conducted. Specific species range maps for the pronghorn are not currently available. However, the U.S. Fish and Wildlife Species Profile Page² identifies the pronghorn to be known or believed to occur in Yuma, Pinal, Maricopa, Pima, La Paz and Santa Cruz counties. The pronghorn recovery plan (USFWS, 1998) describes pronghorn habitat as broad alluvial valleys ranging in elevation from 122 meters in the west to 488 meters in the east. Using the county and elevation information, the species’ range was compared to the aggregated NASS reported acres from the 2012 Census of Agriculture Full Report, and the 5 year aggregated CDL crop group layers.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A009. Accessed 6/16/2015.³ Critical habitat designation status determined using U.S. Fish & Wildlife Service’s Environmental Conservation Online System (ECOS) species profiles.

To calculate the NASS overlap, first all the reported crops from the 2012 Census of Agriculture Full Report were cross walked into the 11 EFED crop groups for each county. All counties within the species range were selected from the aggregated crop group table, each crop was summed to generate the total NASS acres, and then percent overlap was calculated.

The CDL is the best available land cover data to spatially characterize agricultural crops nationally. As with any land cover data, there will be errors present. The accuracy of the CDL is well documented on a state by state basis. Essentially, major commodity crops have a more robust training and validation dataset than minor crops, and their accuracy values correspond accordingly. Several methods have been employed to minimize data errors within the CDL.

The CDL has over 100 cultivated classes hierarchically grouped into 11 general classes. Combining classes reduces errors of omission and commission between similar crop categories. The CDL is also annually produced. Five years of CDL from 2010-2014 were temporally aggregated. The concept is that anywhere a class occurs within those 5 years is represented as a temporally aggregated individual class. Temporal aggregation also accounts for crop rotations.

The CDL's agricultural classes were further refined by comparing county level NASS 2012 Census of Agriculture (CoA) acreage reports to county level CDL acreages. If a county's CDL acreage for a given class was lower than the CoA, EPA expanded the CDL class's extent within cultivated areas until the CDL acreage matched the CoA acreage. Using the temporally and thematically aggregated CDL as an input, EPA developed a script that compares each CDL crop group in each county to the corresponding CoA acreage report. If the CDL acreage was less than NASS, EPA expanded the raster in 1 pixel iterations until the CoA value was reached, or the area within the county's cultivated mask was built out. Region growing was restricted using the most recent CDL Cultivated Layer as a mask, so as to avoid buffering into any non-agricultural land cover types. This method reduces land cover mapping errors by adjusting the extent of each category to the best available census values.

To calculate the overlap of the 5 year CDL-aggregated layers, the zonal statistics tool in ArcGIS was used to count the pixels for each layer within the species range. These counts were converted to an area measurement, and the percent overlap calculated. This process was repeated to calculate the overlap of each crop group layer with the species range between 122 and 488 m using the National Elevation Dataset. The National Elevation Dataset was downloaded on May 26, 2015 from: <http://ned.usgs.gov/>.

In Yuma, Pinal, Maricopa, Pima, La Paz and Santa Cruz counties between 122 and 488 meters, there was no identified soybean production according to either the NASS or CDL datasets. Cotton production was limited to 0.24% (CDL) to 0.74% (NASS) of the area in those counties at this elevation. Since the screening level assessment identified that risks to mammals are not anticipated for dicamba use on dicamba-tolerant cotton (levels of concern were not exceeded for exposure to either dicamba or its degradate DCSA), **a No Effect (NE) determination is concluded for pronghorn feeding on cotton fields.** Since the crop overlap analysis suggests

that there is no soybean cropland co-occurrence with pronghorn range, EPA also **concludes a No Effect (NE) determination for pronghorn from soybean uses**

Critical Habitat Determinations

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis consistent with the Overview Document as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife Service or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species. The Agency will conclude "modification" of designated critical habitat if the range of designated critical habitat co-occurs with the states subject to the Federal action and one or more of the following conditions exist:

1. The available Services' information indicates that cotton or soybean fields are habitat for the species and there is a "may affect" determination for the species associated with exposure to dicamba DGA salt or its degradate, DCSA, as labeled.
2. The available Services' information indicates that the species uses cotton or soybean fields and one or more effects on taxonomic groups predicted for dicamba DGA salt or its degradate DCSA, on cotton and soybean fields would modify one or more of the designated PCEs.

If neither of the above conditions are met, EPA concludes "no modification."

Results of Analysis

Of the 322 listed species within the states, there are 308 species identified in the effects determinations as not using cotton or soybean fields and 14 species using these fields (**Appendix 3**). Critical habitats have been designated for 122 of the 322 species. One-hundred sixteen (116) species with critical habitat were judged to not use cotton or soybean fields and so the critical habitat determination for these species was "no modification."

The remaining 6 species with critical habitat designations were assumed to use cotton or soybean fields and so the previous listed species effects determinations were consulted to ascertain if any were determined to be at risk for direct adverse effects. None of the species were determined to be at risk for direct adverse effects, so the PCE's listed in the Services' critical habitat designations were consulted to determine if, in light of the screening assessment risk findings, they would be impacted by on-field exposure to dicamba DGA salt. For all but one of these species, the PCE's are not relatable to agricultural fields and so a determination of no modification has been made for these 5 species.

The only remaining species using cotton or soybean fields and with critical habitat PCE's relatable to agricultural fields was the whooping crane, for which agricultural fields were discussed as providing waste grain as a potential food source for migratory cranes. The only way the proposed dicamba DGA salt could affect this PCE is by making grain potentially toxic to the birds. As there is unlikely to be any edible waste grain remaining following cotton harvesting, it is unlikely that the proposed dicamba DGA salt use on cotton could affect this PCE, however the proposed use on soybean could affect this PCE by making waste soybean grain potentially toxic.

The Health Effects Division summarized available soybean grain residues of dicamba in the Human Health Risk Assessment for the Registration Eligibility Decision for Dicamba and Associated Salts (DP317703). Based on the soybean trials results, maximum residues of dicamba were 0.04 ppm in hay, 0.097 ppm in forage, and 8.13 ppm in seed 6-8 days post treatment (MRIDs 43814101 and 44089307). These measured values were used to set the tolerance value of 10 ppm for soybean seeds. The measured residues are not reasonably expected to be at a level raising a concern for direct effects to the whooping crane because the direct effects assessment for this species (presented in the Section 3 Risk Assessment Refined Endangered Species Assessment that assessed risks to endangered species in 16 states (Arkansas, Kansas, Louisiana, Illinois, Indiana, Iowa, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin {DP 416416, 420160, 420159, 420352, 421434, 421723})) did not establish a concern for residues in other dietary items at much **higher** (~ 1 order of magnitude) concentrations than would occur at the maximum measured residues in seed or if residues were present even at the tolerance level of 10.0 ppm. Because this analysis shows no direct effects of dicamba at levels that would be expected in the fields as waste grain, an indirect effect, there is no modification of critical habitat. Similarly, measured DCSA residues in waste soybean grain (0.44 ppm) would be well below the estimated DCSA concentrations in arthropods (42.5 ppm) used in the direct effects assessment for this species (D416516+, pp. 9-10). Therefore, whooping crane critical habitat within the 11 states in this refined assessment would not be modified.

Summary of Determinations for Critical Habitat

The Agency has determined that the proposed labeled use of dicamba DGA salt on cotton and soybeans will not modify designated critical habitat for all 122 species for which such habitats have been designated in AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV.

A summary of listed species identified as not being on agricultural fields with and without critical habitat designations for the seven states assessed for dicamba DGA salt is provided in **Appendix 3**.

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Appendix 1

Threatened and Endangered Species in Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia, and West Virginia

Common Name	Scientific Name	Taxon
Indiana bat	<i>Myotis sodalis</i>	Mammal
Black-footed ferret	<i>Mustela nigripes</i>	Mammal
Gray wolf	<i>Canis lupus</i>	Mammal
Finback whale	<i>Balaenoptera physalus</i>	Mammal
Humpback whale	<i>Megaptera novaeangliae</i>	Mammal
North Atlantic Right Whale	<i>Eubalaena glacialis</i>	Mammal
Gray bat	<i>Myotis grisescens</i>	Mammal
Canada Lynx	<i>Lynx canadensis</i>	Mammal
Virginia big-eared bat	<i>Corynorhinus (=Plecotus) townsendii virginianus</i>	Mammal
Ocelot	<i>Leopardus (=Felis) pardalis</i>	Mammal
Carolina northern flying squirrel	<i>Glaucomys sabrinus coloratus</i>	Mammal
Mexican long-nosed bat	<i>Leptonycteris nivalis</i>	Mammal
Red-cockaded woodpecker	<i>Picoides borealis</i>	Bird
Mexican spotted owl	<i>Strix occidentalis lucida</i>	Bird
Piping Plover	<i>Charadrius melodus</i> except Great Lakes watershed	Bird
Piping Plover	<i>Charadrius melodus</i> Great Lakes watershed	Bird
Least tern	<i>Sterna antillarum</i>	Bird
Roseate tern	<i>Sterna dougallii dougallii</i>	Bird
Southwestern willow flycatcher	<i>Empidonax traillii eximius</i>	Bird
Lesser Prairie-Chicken	<i>Tympanuchus pallidicinctus</i>	Bird
Whooping crane	<i>Grus americana</i>	Bird
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Reptile
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Reptile
Loggerhead sea turtle	<i>Caretta caretta</i>	Reptile
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Reptile
Green sea turtle	<i>Chelonia mydas</i>	Reptile
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Fish
Pecos gambusia	<i>Gambusia nobilis</i>	Fish
Spotfin Chub	<i>Erimonax monachus</i>	Fish
Slender chub	<i>Erimystax cahni</i>	Fish
Yellowfin madtom	<i>Noturus flavipinnis</i>	Fish
Blackside dace	<i>Phoxinus cumberlandensis</i>	Fish
Arkansas River shiner	<i>Notropis girardi</i>	Fish
Smalleye Shiner	<i>Notropis buccula</i>	Fish
Duskytail darter	<i>Etheostoma percnurum</i>	Fish
Cumberland bean (pearlymussel)	<i>Villosa trabalis</i>	Bivalve
Choctaw bean	<i>Villosa choctawensis</i>	Bivalve

Purple bean	<i>Villosa perpurpurea</i>	Bivalve
Appalachian monkeyface (pearlymussel)	<i>Quadrula sparsa</i>	Bivalve
Chipola slabshell	<i>Elliptio chipolaensis</i>	Bivalve
Cumberland monkeyface (pearlymussel)	<i>Quadrula intermedia</i>	Bivalve
Fat three-ridge (mussel)	<i>Amblema neislerii</i>	Bivalve
Fuzzy pigtoe	<i>Pleurobema strodeanum</i>	Bivalve
Pink mucket (pearlymussel)	<i>Lampsilis abrupta</i>	Bivalve
Dromedary pearlymussel	<i>Dromus dromas</i>	Bivalve
Round Ebonyshell	<i>Fusconaia rotulata</i>	Bivalve
Littlewing pearlymussel	<i>Pegias fabula</i>	Bivalve
Finerayed pigtoe	<i>Fusconaia cuneolus</i>	Bivalve
Gulf moccasinshell	<i>Medionidus penicillatus</i>	Bivalve
Narrow pigtoe	<i>Fusconaia escambia</i>	Bivalve
Ochlockonee moccasinshell	<i>Medionidus simpsonianus</i>	Bivalve
Oval pigtoe	<i>Pleurobema pyriforme</i>	Bivalve
Rough pigtoe	<i>Pleurobema plenum</i>	Bivalve
Shinyrayed pocketbook	<i>Lampsilis subangulata</i>	Bivalve
Shiny pigtoe	<i>Fusconaia cor</i>	Bivalve
Southern kidneyshell	<i>Ptychobranhus jonesi</i>	Bivalve
Southern sandshell	<i>Hamiota (=Lampsilis) australis</i>	Bivalve
Spectaclecase (mussel)	<i>Cumberlandia monodonta</i>	Bivalve
Tan riffleshell	<i>Epioblasma florentina walkeri (=E. walkeri)</i>	Bivalve
Tapered pigtoe	<i>Fusconaia burkei</i>	Bivalve
Rayed Bean	<i>Villosa fabalis</i>	Bivalve
Clubshell	<i>Pleurobema clava</i>	Bivalve
Cumberlandian combshell	<i>Epioblasma brevidens</i>	Bivalve
Oyster mussel	<i>Epioblasma capsaeformis</i>	Bivalve
Cracking pearlymussel	<i>Hemistena lata</i>	Bivalve
Slabside Pearlymussel	<i>Pleuonaia dolabelloides</i>	Bivalve
James spinymussel	<i>Pleurobema collina</i>	Bivalve
Dwarf wedgemussel	<i>Alasmidonta heterodon</i>	Bivalve
Fanshell	<i>Cyprogenia stegaria</i>	Bivalve
Northern riffleshell	<i>Epioblasma torulosa rangiana</i>	Bivalve
Purple bankclimber (mussel)	<i>Elliptoideus sloatianus</i>	Bivalve
Snuffbox mussel	<i>Epioblasma triquetra</i>	Bivalve
Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	Bivalve
Fluted kidneyshell	<i>Ptychobranhus subtentum</i>	Bivalve
Sheepnose Mussel	<i>Plethobasus cyphus</i>	Bivalve
Pecos assiminea snail	<i>Assiminea pecos</i>	Gastropod
Karner blue butterfly	<i>Lycaeides melissa samuelis</i>	Insect
Mitchell's satyr Butterfly	<i>Neonympha mitchellii mitchellii</i>	Insect

Spruce-fir moss spider	<i>Microhexura montivaga</i>	Arachnid
Colorado Butterfly plant	<i>Gaura neomexicana</i> var. <i>coloradensis</i>	Dicot
Pecos (=puzzle, =paradox) sunflower	<i>Helianthus paradoxus</i>	Dicot
Northern wild monkshood	<i>Aconitum noveboracense</i>	Dicot
Small-anthered bittercress	<i>Cardamine micranthera</i>	Dicot
Sneed pincushion cactus	<i>Coryphantha sneedii</i> var. <i>sneedii</i>	Dicot
Small whorled pogonia	<i>Isotria medeoloides</i>	Monocot
Sensitive joint-vetch	<i>Aeschynomene virginica</i>	Dicot
Smooth coneflower	<i>Echinacea laevigata</i>	Dicot
Swamp pink	<i>Helonias bullata</i>	Monocot
Canby's dropwort	<i>Oxypolis canbyi</i>	Dicot
Eastern prairie fringed orchid	<i>Platanthera leucophaea</i>	Monocot
Harperella	<i>Ptilimnium nodosum</i>	Dicot
Michaux's sumac	<i>Rhus michauxii</i>	Dicot
American chaffseed	<i>Schwalbea americana</i>	Dicot
Houghton's goldenrod	<i>Solidago houghtonii</i>	Dicot
Seabeach amaranth	<i>Amaranthus pumilus</i>	Dicot
Virginia sneezeweed	<i>Helenium virginicum</i>	Dicot
Virginia spiraea	<i>Spiraea virginiana</i>	Dicot
Running buffalo clover	<i>Trifolium stoloniferum</i>	Dicot
Ute ladies'-tresses	<i>Spiranthes diluvialis</i>	Monocot
Leedy's roseroot	<i>Rhodiola integrifolia</i> ssp. <i>leedyi</i>	Dicot
American hart's-tongue fern	<i>Asplenium scolopendrium</i> var. <i>americanum</i>	Ferns
Rock gnome lichen	<i>Gymnoderma lineare</i>	Lichen
Sonoran pronghorn	<i>Antilocapra americana sonoriensis</i>	Mammal
Delmarva Peninsula fox squirrel	<i>Sciurus niger cinereus</i>	Mammal
Florida panther	<i>Puma (=Felis) concolor coryi</i>	Mammal
Jaguar	<i>Panthera onca</i>	Mammal
Mount Graham red squirrel	<i>Tamiasciurus hudsonicus grahamensis</i>	Mammal
New Mexico meadow jumping mouse	<i>Zapus hudsonius luteus</i>	Mammal
Lesser long-nosed bat	<i>Leptonycteris curasoae yerbabuenae</i>	Mammal
Preble's meadow jumping mouse	<i>Zapus hudsonius preblei</i>	Mammal
Hualapai Mexican vole	<i>Microtus mexicanus hualpaiensis</i>	Mammal
Red wolf	<i>Canis rufus</i>	Mammal
California condor	<i>Gymnogyps californianus</i>	Bird
Florida grasshopper sparrow	<i>Ammodramus savannarum floridanus</i>	Bird
Yuma clapper rail	<i>Rallus longirostris yumanensis</i>	Bird
Masked bobwhite (quail)	<i>Colinus virginianus ridgwayi</i>	Bird
California least tern	<i>Sterna antillarum browni</i>	Bird
American crocodile	<i>Crocodylus acutus</i>	Reptile
Atlantic salt marsh snake	<i>Nerodia clarkii taeniata</i>	Reptile

New Mexican ridge-nosed rattlesnake	<i>Crotalus willardi obscurus</i>	Reptile
Bluetail mole skink	<i>Eumeces egregius lividus</i>	Reptile
Bog (=Muhlenberg) turtle	<i>Clemmys muhlenbergii</i>	Reptile
Desert tortoise	<i>Gopherus agassizii</i>	Reptile
Eastern indigo snake	<i>Drymarchon corais couperi</i>	Reptile
Narrow-headed gartersnake	<i>Thamnophis rufipunctatus</i>	Reptile
Northern Mexican gartersnake	<i>Thamnophis eques megalops</i>	Reptile
Cheat Mountain salamander	<i>Plethodon nettingi</i>	Amphibian
Frosted Flatwoods salamander	<i>Ambystoma cingulatum</i>	Amphibian
Jemez Mountains Salamander	<i>Plethodon neomexicanus</i>	Amphibian
Reticulated flatwoods salamander	<i>Ambystoma bishopi</i>	Amphibian
Shenandoah salamander	<i>Plethodon shenandoah</i>	Amphibian
Sonora tiger Salamander	<i>Ambystoma tigrinum stebbinsi</i>	Amphibian
Chiricahua leopard frog	<i>Rana chiricahuensis</i>	Amphibian
Humpback chub	<i>Gila cypha</i>	Fish
Maryland darter	<i>Etheostoma sellare</i>	Fish
Colorado pikeminnow (=squawfish)	<i>Ptychocheilus lucius</i>	Fish
Gila topminnow (incl. Yaqui)	<i>Poeciliopsis occidentalis</i>	Fish
Apache trout	<i>Oncorhynchus apache</i>	Fish
Gila trout	<i>Oncorhynchus gilae</i>	Fish
Greenback Cutthroat trout	<i>Oncorhynchus clarki stomias</i>	Fish
Woundfin	<i>Plagopterus argentissimus</i>	Fish
Diamond Darter	<i>Crystallaria cincotta</i>	Fish
Roanoke logperch	<i>Percina rex</i>	Fish
Bonytail chub	<i>Gila elegans</i>	Fish
Chihuahua chub	<i>Gila nigrescens</i>	Fish
Sonora chub	<i>Gila ditaenia</i>	Fish
Virgin River Chub	<i>Gila semimuda (=robusta)</i>	Fish
Yaqui catfish	<i>Ictalurus pricei</i>	Fish
Gila chub	<i>Gila intermedia</i>	Fish
Yaqui chub	<i>Gila purpurea</i>	Fish
Loach minnow	<i>Tiaroga cobitis</i>	Fish
Desert pupfish	<i>Cyprinodon macularius</i>	Fish
Beautiful shiner	<i>Cyprinella formosa</i>	Fish
Okaloosa darter	<i>Etheostoma okaloosae</i>	Fish
Pecos bluntnose shiner	<i>Notropis simus pecosensis</i>	Fish
Little Colorado spinedace	<i>Lepidomeda vittata</i>	Fish
Razorback sucker	<i>Xyrauchen texanus</i>	Fish
Spikedace	<i>Meda fulgida</i>	Fish
Zuni Bluehead Sucker	<i>Catostomus discobolus yarrowi</i>	Fish
Rio Grande silvery minnow	<i>Hybognathus amarus</i>	Fish

Smalltooth sawfish	<i>Pristis pectinata</i>	Fish
Atlantic Sturgeon (gulf subspecies)	<i>Acipenser oxyrinchus desotoi</i>	Fish
Green blossom (pearlymussel)	<i>Epioblasma torulosa gubernaculum</i>	Bivalve
Tubercled blossom (pearlymussel)	<i>Epioblasma torulosa torulosa</i>	Bivalve
Birdwing pearlymussel	<i>Lemiox rimosus</i>	Bivalve
Rough rabbitsfoot	<i>Quadrula cylindrica strigillata</i>	Bivalve
Chittenango ovate amber snail	<i>Succinea chittenangoensis</i>	Gastropod
Flat-spired three-toothed Snail	<i>Triodopsis platysayoides</i>	Gastropod
Virginia fringed mountain snail	<i>Polygyriscus virginianus</i>	Gastropod
Kanab ambersnail	<i>Oxyloma haydeni kanabensis</i>	Gastropod
Alamosa springsnail	<i>Tryonia alamosae</i>	Gastropod
Chupadera springsnail	<i>Pyrgulopsis chupaderae</i>	Gastropod
Roswell springsnail	<i>Pyrgulopsis roswellensis</i>	Gastropod
Koster's springsnail	<i>Juturnia kosteri</i>	Gastropod
Three Forks Springsnail	<i>Pyrgulopsis trivialis</i>	Gastropod
San Bernardino springsnail	<i>Pyrgulopsis bernardina</i>	Gastropod
Socorro springsnail	<i>Pyrgulopsis neomexicana</i>	Gastropod
Pawnee montane skipper	<i>Hesperia leonardus montana</i>	Insect
Uncompahgre fritillary butterfly	<i>Boloria acrocneuma</i>	Insect
Northeastern beach tiger beetle	<i>Cicindela dorsalis dorsalis</i>	Insect
Puritan tiger beetle	<i>Cicindela puritana</i>	Insect
Hay's Spring amphipod	<i>Stygobromus hayi</i>	Crustacean
Madison Cave isopod	<i>Antrolana lira</i>	Crustacean
Socorro isopod	<i>Thermosphaeroma thermophilus</i>	Crustacean
Noel's Amphipod	<i>Gammarus desperatus</i>	Crustacean
Lee County cave isopod	<i>Lirceus usdagalun</i>	Crustacean
Squirrel Chimney Cave shrimp	<i>Palaemonetes cumingii</i>	Crustacean
Acuna Cactus	<i>Echinomastus erectocentrus</i> var. <i>acunensis</i>	Dicot
Fickeisen Plains cactus	<i>Pediocactus peeblesianus fickeiseniae</i>	Dicot
DeBeque phacelia	<i>Phacelia submutica</i>	Dicot
Sacramento prickly poppy	<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>	Dicot
Sentry milk-vetch	<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>	Dicot
Mancos milk-vetch	<i>Astragalus humillimus</i>	Dicot
Osterhout milkvetch	<i>Astragalus osterhoutii</i>	Dicot
Virginia round-leaf birch	<i>Betula uber</i>	Dicot
Navajo sedge	<i>Carex specuicola</i>	Monocot
Lee pincushion cactus	<i>Coryphantha sneedii</i> var. <i>leei</i>	Dicot
Lewton's polygala	<i>Polygala lewtonii</i>	Dicot
Jones Cycladenia	<i>Cycladenia humilis</i> var. <i>jonesii</i>	Dicot
Nichol's Turk's head cactus	<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>	Dicot
Kuenzler hedgehog cactus	<i>Echinocereus fendleri</i> var. <i>kuenzleri</i>	Dicot

Arizona hedgehog cactus	<i>Echinocereus triglochidiatus</i> var. <i>arizonicus</i>	Dicot
Zuni fleabane	<i>Erigeron rhizomatus</i>	Dicot
Gypsum wild-buckwheat	<i>Eriogonum gypsophilum</i>	Dicot
Penland alpine fen mustard	<i>Eutrema penlandii</i>	Dicot
Brady pincushion cactus	<i>Pediocactus bradyi</i>	Dicot
Knowlton's cactus	<i>Pediocactus knowltonii</i>	Dicot
Peebles Navajo cactus	<i>Pediocactus peeblesianus</i> var. <i>peeblesianus</i>	Dicot
Siler pincushion cactus	<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>	Dicot
North Park phacelia	<i>Phacelia formosula</i>	Dicot
Arizona Cliff-rose	<i>Purshia</i> (= <i>Cowanina</i>) <i>subintegra</i>	Dicot
Northeastern bulrush	<i>Scirpus ancistrochaetus</i>	Monocot
Colorado hookless Cactus	<i>Sclerocactus glaucus</i>	Dicot
Mesa Verde cactus	<i>Sclerocactus mesae-verdae</i>	Dicot
San Francisco Peaks ragwort	<i>Packera franciscana</i>	Dicot
Todsen's pennyroyal	<i>Hedeoma todsenii</i>	Dicot
Sandplain gerardia	<i>Agalinis acuta</i>	Dicot
Kearney's blue-star	<i>Amsonia kearneyana</i>	Dicot
Welsh's milkweed	<i>Asclepias welshii</i>	Dicot
Sacramento Mountains thistle	<i>Cirsium vinaceum</i>	Dicot
Cochise pincushion cactus	<i>Coryphantha robbinsorum</i>	Dicot
Pima pineapple cactus	<i>Coryphantha scheeri</i> var. <i>robustispina</i>	Dicot
clay-loving wild buckwheat	<i>Eriogonum pelinophilum</i>	Dicot
Peter's Mountain mallow	<i>Iliamna corei</i>	Dicot
Holmgren milk-vetch	<i>Astragalus holmgreniorum</i>	Dicot
Huachuca water-umbel	<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>	Dicot
Pagosa skyrocket	<i>Ipomopsis polyantha</i>	Dicot
Dudley Bluffs twinpod	<i>Physaria obcordata</i>	Dicot
Shale barren rock cress	<i>Arabis serotina</i>	Dicot
Penland beardtongue	<i>Penstemon penlandii</i>	Dicot
Holy Ghost ipomopsis	<i>Ipomopsis sancti-spiritus</i>	Dicot
Dudley Bluffs bladderpod	<i>Lesquerella congesta</i>	Dicot
Parachute beardtongue	<i>Penstemon debilis</i>	Dicot
Canelo Hills ladies'-tresses	<i>Spiranthes delitescens</i>	Monocot
Gierisch mallow	<i>Sphaeralcea gierischii</i>	Dicot
Aboriginal Prickly-apple	<i>Harrisia aboriginum</i>	Dicot
Apalachicola rosemary	<i>Conradina glabra</i>	Dicot
Avon Park harebells	<i>Crotalaria avonensis</i>	Dicot
Beach jacquemontii	<i>Jacquemontia reclinata</i>	Dicot
Beautiful pawpaw	<i>Deeringothamnus pulchellus</i>	Dicot
Brooksville bellflower	<i>Campanula robinsiae</i>	Dicot
Cape Sable Thoroughwort	<i>Chromolaena frustrata</i>	Dicot
Carter's mustard	<i>Warea carteri</i>	Dicot
Carter's small-flowered flax	<i>Linum carteri carteri</i>	Dicot

Chapman rhododendron	<i>Rhododendron chapmanii</i>	Dicot
Cooley's meadowrue	<i>Thalictrum cooleyi</i>	Dicot
Cooley's water-willow	<i>Justicia cooleyi</i>	Dicot
Crenulate lead-plant	<i>Amorpha crenulata</i>	Dicot
Deltoid spurge	<i>Chamaesyce deltoidea</i> ssp. <i>deltoidea</i>	Dicot
Etonia rosemary	<i>Conradina etonia</i>	Dicot
Florida bonamia	<i>Bonamia grandiflora</i>	Dicot
Florida brickell-bush	<i>Brickellia mosieri</i>	Dicot
Florida golden aster	<i>Chrysopsis floridana</i>	Dicot
Florida semaphore cactus	<i>Consolea corallicola</i>	Dicot
Florida skullcap	<i>Scutellaria floridana</i>	Dicot
Florida ziziphus	<i>Ziziphus celata</i>	Dicot
Four-petal pawpaw	<i>Asimina tetramera</i>	Dicot
Fragrant prickly-apple	<i>Cereus eriophorus</i> var. <i>fragrans</i>	Dicot
Fringed campion	<i>Silene polypetala</i>	Dicot
Garber's spurge	<i>Chamaesyce garberi</i>	Dicot
Garrett's mint	<i>Dicerandra christmanii</i>	Dicot
Gentian pinkroot	<i>Spigelia gentianoides</i>	Dicot
Godfrey's butterwort	<i>Pinguicula ionantha</i>	Dicot
Highlands scrub hypericum	<i>Hypericum cumulicola</i>	Dicot
Key tree cactus	<i>Pilosocereus robinii</i>	Dicot
Lakela's mint	<i>Dicerandra immaculata</i>	Dicot
Longspurred mint	<i>Dicerandra cornutissima</i>	Dicot
Miccosukee gooseberry	<i>Ribes echinellum</i>	Dicot
Okeechobee gourd	<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>	Dicot
Papery whitlow-wort	<i>Paronychia chartacea</i>	Dicot
Pigeon wings	<i>Clitoria fragrans</i>	Dicot
Pygmy fringe-tree	<i>Chionanthus pygmaeus</i>	Dicot
Roan Mountain Bluet	<i>Hedyotis purpurea</i> var. <i>montana</i>	Dicot
Rugel's pawpaw	<i>Deeringothamnus rugelii</i>	Dicot
Sandlace	<i>Polygonella myriophylla</i>	Dicot
Scrub blazingstar	<i>Liatris ohlingerae</i>	Dicot
Scrub buckwheat	<i>Eriogonum longifolium</i> var. <i>gnaphalifolium</i>	Dicot
Scrub lupine	<i>Lupinus aridorum</i>	Dicot
Scrub mint	<i>Dicerandra frutescens</i>	Dicot
Scrub plum	<i>Prunus geniculata</i>	Dicot
Short-leaved rosemary	<i>Conradina brevifolia</i>	Dicot
Small's milkpea	<i>Galactia smallii</i>	Dicot
Snakeroot	<i>Eryngium cuneifolium</i>	Dicot
Telephus spurge	<i>Euphorbia telephioides</i>	Dicot
Tiny polygala	<i>Polygala smallii</i>	Dicot
White birds-in-a-nest	<i>Macbridea alba</i>	Dicot
Wide-leaf warea	<i>Warea amplexifolia</i>	Dicot

Wireweed	<i>Polygonella basiramia</i>	Dicot
Bartram's Hairstreak Butterfly	<i>Strymon acis bartrami</i>	Insect
Florida Leafwing Butterfly	<i>Anaea troglodyta floridalis</i>	Insect
Miami Blue Butterfly	<i>Cyclargus (=Hemiargus) thomasi bethunebakeri</i>	Insect
Schaus swallowtail butterfly	<i>Heraclides aristodemus ponceanus</i>	Insect
Florida perforate cladonia	<i>Cladonia perforata</i>	Lichen
Anastasia Island beach mouse	<i>Peromyscus polionotus phasma</i>	Mammal
Choctawhatchee beach mouse	<i>Peromyscus polionotus allophrys</i>	Mammal
Florida Bonneted bat	<i>Eumops floridanus</i>	Mammal
Florida salt marsh vole	<i>Microtus pennsylvanicus dukecampbelli</i>	Mammal
Key deer	<i>Odocoileus virginianus clavium</i>	Mammal
Key Largo cotton mouse	<i>Peromyscus gossypinus allapaticola</i>	Mammal
Key Largo woodrat	<i>Neotoma floridana smalli</i>	Mammal
Lower Keys marsh rabbit	<i>Sylvilagus palustris hefneri</i>	Mammal
Perdido Key beach mouse	<i>Peromyscus polionotus trissyllepsis</i>	Mammal
Rice rat	<i>Oryzomys palustris natator</i>	Mammal
Southeastern beach mouse	<i>Peromyscus polionotus niveiventris</i>	Mammal
St. Andrew beach mouse	<i>Peromyscus polionotus peninsularis</i>	Mammal
West Indian Manatee	<i>Trichechus manatus latirostris</i>	Mammal
Audubon crested caracara	<i>Polyborus plancus audubonii</i>	Bird
Cape Sable seaside sparrow	<i>Ammodramus maritimus mirabilis</i>	Bird
Everglade snail kite	<i>Rostrhamus sociabilis plumbeus</i>	Bird
Florida scrub-jay	<i>Aphelocoma coerulescens</i>	Bird
Kirtland's Warbler	<i>Setophaga kirtlandii</i>	Bird
Wood stork	<i>Mycteria americana</i>	Bird
Bachman's warbler (=wood)	<i>Vermivora bachmanii</i>	Bird
Sand skink	<i>Neoseps reynoldsi</i>	Reptile
Stock Island tree snail	<i>Orthalicus reses (not incl. nesodryas)</i>	Gastropod
Britton's beargrass	<i>Nolina brittoniana</i>	Monocot
Harper's beauty	<i>Harperocallis flava</i>	Monocot
Johnson's seagrass	<i>Halophila johnsonii</i>	Monocot
Knieskern's Beaked-rush	<i>Rhynchospora knieskernii</i>	Monocot
Florida torreyia	<i>Torreya taxifolia</i>	Conf/cycds
Elkhorn coral	<i>Acropora palmate</i>	Coral
Staghorn coral	<i>Acropora cervicornis</i>	Coral

Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Filed by Assumed Mitigation for Spray Drift

The spray drift (in-field buffer) and rainfast mitigations discussed in the cotton section 3 ecological risk assessment (D404823), the concurrently issued soybean addendum (D426789) and at the beginning of this assessment are anticipated to restrict dicamba and DCSA residues above any threshold toxicity values to the agricultural field. Therefore, the following table describes the habitat and rationale for all listed species that were determined to not use cotton and soybean fields or resources that may overlap with dicamba DGA uses.

Species	Habitat	Rationale	Source
Terrestrial Animals			
Anastasia Island beach mouse <i>(Peromyscus polionotus phasma)</i>	Primarily located on coastal sand dunes, coastal scrub, sandy areas, and inland wood vegetation. The species occupy both frontal (primary and secondary) and scrub dunes. Habitat size is 3-14 linear miles of beach. Young beach mice move an average of 432 m (1,415 ft) before establishing a home range. Elevated coastal scrub provides refugia from storms.	The proposed uses of dicamba DGA are not expected to overlap with scrub, beach, dune or woody habitat.	US FWS. 1993. Recovery Plan for the Anastasia Island and Southeastern Beach Mouse. Atlanta Georgia. 30 pp. http://ecos.fws.gov/docs/recovery_plan/930923b.pdf . US FWS. 2007. Anastasia Island beach mouse <i>(Peromyscus polionotus phasma)</i> , 5-Year Review: Summary and Evaluation. Jacksonville, Florida. 25 pp. http://ecos.fws.gov/docs/five_year_review/doc1086.pdf .
Bachman's warbler <i>(Vermivora bachmanii)</i>	Breeds in palustrine forested wetlands; seen near longleaf pine forest near brackish marsh. (USFWS 2007)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2007. Five Year Review: http://ecos.fws.gov/docs/five_year_review/doc1037.pdf
Bartram's Hairstreak Butterfly, <i>(Strymon acis bartrami)</i>	Mostly occur within pine rocklands, specifically those that retain their mutual and sole host plant, pineland croton. Adult butterflies will also make use of rockland hammock and hydric pine flatwood vegetation when interspersed within the pine rockland habitat.	The proposed uses of dicamba DGA are not expected to overlap with pine rockland habitat.	US FWS. 2014. Endangered Status for the Florida Leafwing and Bartam's Scrub-Hairstreak Butterflies. http://www.gpo.gov/fdsys/pkg/FR-2014-08-12/pdf/2014-18614.pdf
Black-footed ferret <i>(Mustela nigripes)</i>	The black-footed ferret relies on prairie dog colonies for both food and shelter.	The proposed dicamba DGA uses are not expected to overlap with prairie dog colonies.	USFWS. 2008. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2364.pdf

Butterfly, Karner blue (<i>Lycaeides melissa samuelis</i>)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy (US FWS, 2003. pp.28-30)	The proposed dicamba DGA uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf
Butterfly, Mitchell's satyr (<i>Neonympha mitchellii mitchellii</i>)	Mitchell's satyr habitat is best characterized as a sedge-dominated fen community; Known habitats are all peatlands but range along a continuum from prairie/bog fen to sedge meadow/swamp. However, certain attributes at each site remain fairly constant. All historical and active habitats have a herbaceous community which is dominated by sedges, usually <i>Carex stricta</i> , with scattered deciduous and/or coniferous trees, most often <i>L. laricina</i> or <i>Juniperus virginiana</i> (red cedar) (US FWS 1998, pp. 11-12).	The proposed dicamba DGA uses are not expected to overlap with wetlands or areas with sedge communities.	USFWS 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf
Cape Sable seaside sparrow (<i>Ammodramus maritimus mirabilis</i>)	Species habitat consists of short hydroperiod prairie, freshwater to brackish marshes, mixed marl prairie community that often includes muhly grass (<i>Muhlenbergia filipes</i>). These short-hydroperiod prairies contain moderately dense, clumped grasses, with open space permitting ground movements by the sparrows. Sparrows tend to avoid tall, dense, saw- grass-dominated communities, spike-rush (<i>Eleocharis sp.</i>) marshes, extensive cattail (<i>Typha sp.</i>) monocultures, long-	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats and open areas. Agricultural field monocultures are not expected to provide adequate habitat for the sparrow.	US FWS. 1999. South Florida multiple-species recovery plan. Available on FWS website. http://ecos.fws.gov/docs/recovery_plan/140903.pdf http://www.fws.gov/southeast/vbpdfs/species/birds/csss.pdf

	hydroperiod wetlands with tall, dense vegetative cover, and sites supporting woody vegetation. Cape Sable seaside sparrows avoid sites with permanent water cover.		
Carolina northern flying squirrel (<i>Glaucomys sabrinus coloratus</i>)	Species composition of the occupied forest may vary in different locations, some combination of hardwoods and conifers (particularly spruce and fir) appears essential to support these animals...Food sources for the Carolina northern flying squirrel include fungi, lichens, staminate cones, insects, and other animal matter (US FWS 1990, p. 6-7)	The proposed dicamba DGA uses are not expected to overlap with hardwood and conifer forests.	USFWS. 1990. Recovery Plan for Appalachian Northern Flying Squirrels. United States Fish and Wildlife Service.
Chittenango ovate amber snail (<i>Succinea chittenangoensis</i>)	Habitat is in a ravine at the base of the 167-foot-tall waterfall formed by Chittenango Creek. The snail requires cool to mild-temperature, moist conditions provided by the waterfalls and mist in its environment. The base of the waterfall, and the ledges where it is found comprise an early successional sere that is periodically rejuvenated to a bare substrate by floodwaters. Seems to prefer green vegetation such as the various mosses, liverworts, and other low herbaceous vegetation found within the spray zone adjacent to the Falls (US FWS 2006.	The proposed uses of dicamba DGA are not expected to overlap with waterfall habitat.	US FWS. 2006. Recovery Plan for the Chittenango Ovate Amber Snail http://ecos.fws.gov/docs/recovery_plan/060823.pdf
Choctawhatchee beach mouse (<i>Peromyscus polionotus alloparys</i>)	The beach mouse inhabits coastal sand dunes and coastal scrub; primary, secondary, and interior or scrub dunes (vegetation includes sea oats, grasses, woody goldenrod, false rosemary, scrub oaks, and yaupon holly). Approximately 2,500 acres of	The proposed uses of dicamba DGA are not expected to overlap with sand dune and coastal scrub habitat.	US FWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. http://ecos.fws.gov/docs/recovery_plan/870812.pdf .

	habitat separated into four populations.		US FWS. 2007. Choctawhatchee Beach Mouse (<i>Peromyscus polionotus alloparys</i>), 5-Year Review: Summary and Evaluation. Panama City, Florida. 25 pp. http://ecos.fws.gov/docs/five_year_review/doc1081.pdf .
Everglade snail kite <i>(Rostrhamus sociabilis plumbeus)</i>	Located on wetlands, lowland freshwater marshes, and shallow vegetated edges of lakes (natural and manmade). Range restricted to the watersheds of the Everglades, Lake Okeechobee and Kissimmee, and Upper St. John River.	The proposed uses of dicamba DGA are not expected to overlap with wetland habitat	US FWS. 1999. South Florida multiple-species recovery plan. http://ecos.fws.gov/docs/recovery_plan/140903.pdf http://www.fws.gov/verobeach/MSRPPDFs/EvergladeSnailKite.pdf
Flat-spined three-toothed Snail <i>(Triodopsis platysayoides)</i>	Found in cool, moist, deep fissures in shale, sandstone, and limestone outcrops and in talus. Outcrops of rock more than one meter high are considered potential habitat if they contain cracks and crevices at least one meter deep. Rock structure is more important than the age and type of trees growing on rock. At night, the species has been observed foraging and resting under wet leaves, next to rock structures.	The proposed uses of dicamba DGA are not expected to overlap with rock outcrops.	US FWS. 2007. Flat-spined Three-Toothed Snail (<i>Triodopsis platysayoides</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1172.pdf
Florida Bonneted bat <i>(Eumops floridanus)</i>	Habitat mainly consists of foraging areas and roosting sites, including artificial structures. Open, fresh water and wetlands provide prime foraging areas for bats.	The proposed uses of dicamba DGA are not expected to overlap with wetland and other aquatic habitats.	US FWS. 2013. Endangered Species Status for the Florida Bonneted Bat. http://www.gpo.gov/fdsys/pkg/FR-2013-10-02/pdf/2013-23401.pdf
Florida Leafwing Butterfly <i>(Anaea troglodyta floralis)</i>	Mostly occur within pine rocklands, specifically those that retain their mutual and sole host plant, pineland croton. Adult butterflies will also make use of rockland hammock and hydric pine flatwood vegetation when interspersed within the pine rockland habitat.	The proposed uses of dicamba DGA are not expected to overlap with pine rockland and other rocky or woody habitats.	US FWS. 2014. Endangered Status for the Florida Leafwing and Bartam's Scrub-Hairstreak Butterflies. http://www.gpo.gov/fdsys/pkg/FR-2014-08-12/pdf/2014-18614.pdf
Florida salt marsh vole	Located on salt marsh habitats dominated by salt grass (<i>Distichlis spicata</i>), but may also contain smooth cordgrass (<i>Spartina</i>	The proposed uses of dicamba DGA are not expected to overlap with salt marsh habitats.	US FWS. 1997. Recovery plan for the Florida salt marsh vole. U.S. Fish and Wildlife Service, Atlanta Georgia. 9pp.

<i>(Microtus pennsylvanicus dukecampbelli)</i>	<i>alterniflora</i>) and glasswort (<i>Salicornia</i> spp.) vegetation. Dense ground-level vegetation is common. Estimated home range is 804 square meters.		http://ecos.fws.gov/docs/recovery_plan/970930d.pdf .
Florida scrub-jay <i>(Aphelocoma coerulescens)</i>	Habitat is mostly scrub communities (primarily oak scrub) with fine, white, drained sand. Currently only occurs in scattered and often small patches in peninsular Florida.	The proposed uses of dicamba DGA are not expected to overlap with scrubland habitats.	US FWS. 1990. Recovery Plan for the Florida Scrub Jay. http://ecos.fws.gov/docs/recovery_plan/900509.pdf
Frosted Flatwoods salamander <i>(Ambystoma cingulatum)</i>	Fire-maintained, open-canopied, flatwoods and savannas dominated by longleaf pine (<i>Pinus palustris</i>), with naturally occurring slash pine (<i>P. ellioti</i>) in wetter areas. Adults spend most of their lives underground. Breed in small, isolated ephemeral ponds (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with flatwoods or savannas.	USFWS 2009. Federal Register, vol. 74, No. 62. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
<u>Bat, gray (Myotis grisescens)</u>	Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small	The proposed dicamba DGA uses are not expected to encompass caves or the forest/open water areas where bats forage.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf

	lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when migrating (US FWS, 1982. pp. 6-7).		
Key deer <i>(Odocoileus virginianus clavium)</i>	Habitat consists of pine flatwoods, pine rocklands, hardwood hammocks, buttonwood wetlands, mangrove wetlands, and freshwater wetlands.	The proposed uses of dicamba DGA are not expected to overlap with wetland, woodland or rocky habitats.	US FWS. 1999. South Florida multi-species recovery plan, Florida. United States Fish and Wildlife Service. http://www.fws.gov/verobeach/MSRPPDFs/KeyDeer.pdf .
Key Largo cotton mouse <i>(Peromyscus gossypinus allapaticola)</i>	Tropical hardwood hammock; upland forest; tall canopy (average 9.8 m) and an open understory; canopy trees include black ironwood (<i>Krugiodendron ferreum</i>), gumbo limbo (<i>Bursera simaruba</i>) Jamaican dogwood (<i>Piscidia piscipula</i>), mahogany (<i>Swietenia mahagani</i>), pigeon plum (<i>Coccoloba diversifolia</i>), poisonwood (<i>Metopium toxiferum</i>), trangler fig (<i>Ficus aurea</i>), and wild tamarind (<i>Lysiloma latisiliquum</i>). Hammock understory contains torchwood (<i>Amyris elemifera</i>), milkbark (<i>Drypetes diversifolia</i>), wild coffee (<i>Psychotria nervosa</i>), marlberry (<i>Aroisia escallonioides</i>), stoppers (<i>Eugenia</i> spp.), soldierwood (<i>Colubrina elliptica</i>), crabwood (<i>Gymnanthes lucida</i>), and velvetseed (<i>Guettarda scabra</i>); ground cover contains cheese shrub (<i>Morinda royoc</i>) and snowberry (<i>Chicocoea alba</i>); adjacent <i>Salicornia</i> coastal strands, recently burned fern-dominated (<i>Pteridium aquilinum</i>) areas.	The proposed uses of dicamba DGA are not expected to overlap with wooded habitats.	US FWS. 2009. Key Largo Cotton Mouse (<i>Peromyscus gossypinus allapaticola</i>), 5-Year Review: Summary and Evaluation. Vero Beach, Florida. 19 pp. http://ecos.fws.gov/docs/five_year_review/doc2378.pdf . US FWS. 1999. Key Largo Cotton Mouse in South Florida Multi-Species Recovery Plan. Atlanta, Georgia. pgs. 4-79 - 4-95. 2172 pp. http://www.fws.gov/verobeach/MSRPPDFs/KeyLargoCottonmouse.pdf ; http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf .

Key Largo woodrat <i>(Neotoma floridana smalli)</i>	Habitat consists of tropical hardwood hammocks; mature and younger hardwood hammocks, as well as disturbed areas adjacent to mature hammocks.	The proposed uses of dicamba DGA are not expected to overlap with wooded habitats.	US FWS. 1999. Key Largo Woodrat (<i>Neotoma floridana smalli</i>) in South Florida Multi-Species Recovery Plan. Atlanta, Georgia. pgs. 4-195 - 4-216. 2172 pp. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf http://www.fws.gov/verobeach/MSRPPDFs/KeyLargoWoodrat.pdf
Kirtland's Warbler (<i>Setophaga kirtlandii</i>)	Kirtland's warblers generally occupy jack pine stands that are 5-23 years old and at least 30 acres in size. Stands with less than 20% canopy over are rarely used for nesting. Occupied stands usually occur on dry, excessively drained and nutrient poor glacial outwash sands. They are structurally homogenous with trees ranging from 1.7-5.0 m in height (US FWS, 2012, p. 24). Species is migratory and mobile species and breeding areas are found in Wisconsin.	The proposed dicamba DGA salt uses are not expected to overlap with jack pine stands.	USFWS. 2012. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4045.pdf
Lower Keys marsh rabbit <i>(Sylvilagus palustris hefneri)</i>	Found in salt marshes, freshwater bordered with hammocks and flatwoods; transition zone on grasses and sedges, grassy marshes and prairies; coastal berm. Species occasionally use low shrub marshes and mangrove communities; salt marsh-butonwood transition zones, freshwater wetlands; upland pinelands and hammocks.	The proposed uses of dicamba DGA are not expected to overlap with wetland or wooded habitats.	US FWS. 1999. Lower Keys Rabbit (<i>Sylvilagus palustris hefneri</i>) in South Florida Multi-Species Recovery Plan. Atlanta, Georgia. pgs. 4-151 - 4-172. 2172 pp. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf ; and http://www.fws.gov/southeast/vbpdfs/species/mammals/lkmr.pdf US FWS. 2007. Lower Keys Rabbit (<i>Sylvilagus palustris hefneri</i>) 5-Year review: Summary and Evaluation. Vero Beach, Florida. http://ecos.fws.gov/docs/five_year_review/doc1110.pdf US FWS. 1990. Endangered and Threatened Wildlife and Plants; Endangered Status for

			<p>the Lower Keys Rabbit and Threatened Status for the Squirrel Chimney Cave Shrimp. Federal Register Vol. 55, No. 120. June 21, 1990. pgs 25588-25591.</p> <p>http://ecos.fws.gov/docs/federal_register/fr1715.pdf</p>
<p>Lesser long-nosed bat (<i>Leptonycteris curasoae yerbabuenae</i>)</p>	<p>The bat has evolved an apparent mutualistic association with columnar cacti <i>Agave</i> sp. The bat is principally a nectar feeder, foraging on the flowers of <i>Agave</i>, and in some minor proportions consuming the pollen, fruits, and any incidental insects associated with the flowers. The bat uses caves and mines as day roosts.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with the caves and mines the bat uses as day roosts and The bat's major resource need, <i>Agave</i> plants are not expected to be on soybean and cotton fields.</p>	<p>USFWS. 1995. Recovery Plan.</p> <p>http://ecos.fws.gov/docs/recovery_plan/970304.pdf</p>
<p>Mexican spotted owl (<i>Strix occidentalis lucida</i>)</p>	<p>Forest and canyonlands in SW U.S. (USFWS 2011, p. 7).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with forests or Canyonlands.</p>	<p>USFWS 2011. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/FR00000557-%20BP031995%20Draft%20MSO%20Recovery%20Plan%20First%20Revision.pdf</p>
<p>Miami Blue Butterfly</p> <p>(<i>Cyclargus</i> (= <i>Hemiargus</i>) <i>thomasi bethunebakeri</i>)</p>	<p>Species is a coastal butterfly reported to occur in openings and around the edges of hardwood hammocks (forest habitats characterized by broad-leaved evergreens), and in other communities adjacent to the coast that are prone to frequent disturbances (e.g., coastal berm hammocks, dunes, and scrub).</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with wooded, coastal or scrubland habitats.</p>	<p>US FWS. 2012. Listing of the Miami Blue Butterfly as Endangered Throughout its Range: Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly in Coastal South and Central Florida: Final rule.</p> <p>http://www.gpo.gov/fdsys/pkg/FR-2012-04-06/pdf/2012-8088.pdf</p>
<p>Kanab ambersnail (<i>Oxyloma haydeni kanabensis</i>)</p>	<p>The known Kanab ambersnail populations generally occur within habitat conditions described as marshes and other wetlands watered by springs and seeps at the base of sandstone or limestone cliffs.</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.</p>	<p>US FWS. 2011. Kanab ambersnail (<i>Oxyloma haydeni kanabensis</i>) 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3885.pdf</p>

	The sites this snail is found (Three Lakes and Vasey's Paradise), vary in their vegetation distribution and water flow, with the Three Lakes site being more of a marsh habitat, while the Vasey's Paradise site is a cool dolomitic spring habitat.		
Virginia fringed mountain snail (<i>Polygyriscus virginianus</i>)	Usually in areas where limestone is mixed with clay soil and is associated with permanently damp rock fragments and angular limestone pieces. These areas are heavily shaded and may be overgrown with honeysuckle. Living individuals occur in the soil at depths of four to twenty-four inches. Live snails have never been observed on the soil surface	The proposed uses of dicamba DGA are not expected to overlap with limestone outcrops.	US FWS species life-history profile http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=G00Z#lifeHistory
Narrow-headed gartersnake (<i>Thamnophis rufipunctatus</i>)	PCE's are: 1) stream habitat 2) up to 600 ft space on either side of bankful stage river w/ sufficient structural characteristics to support life-history functions, 3) prey base of fish, 4) absence or low levels only of nonnative sunfish and catfish, bullfrogs and/or crayfish.	The proposed uses of dicamba DGA are not expected to overlap with stream or floodplain habitats.	USFWS 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Federal Register V78(132): 41550—41608 http://www.gpo.gov/fdsys/pkg/FR-2013-07-10/pdf/2013-16520.pdf
New Mexico meadow jumping mouse (<i>Zapus hudsonius luteus</i>)	PCE's are: 1) riparian communities along rivers, streams, springs and wetlands, 2) flowing water that provides saturated soils supporting tall herbaceous vegetation comprised mostly of sedges and forbs, sufficient areas along a stream, ditch or canal that contain suitable habitat, adjacent floodplain and upland areas extending ~100m from water's edge.	The proposed uses of dicamba DGA are not expected to overlap with riparian communities and saturated soils.	USFWS, 2013. Endangered and Threatened Wildlife and Plants; Proposed Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse. Federal Register V78(119): 37328—37363 http://www.gpo.gov/fdsys/pkg/FR-2013-06-20/pdf/2013-14366.pdf
Northeastern beach tiger beetle (<i>Cicindela dorsalis dorsalis</i>)	Open sand flats, dunes, water edges, beaches, woodland paths, and sparse grassy areas. Maryland (Calvert and Tangier Sound counties); Massachusetts (Coastal Massachusetts and	The proposed uses of dicamba DGA are not expected to overlap with beach habitats.	US FWS. 1994. Recovery Plan for Northeastern Beach Tiger Beetle http://ecos.fws.gov/docs/recovery_plan/940929b.pdf

	Islands); Virginia (Eastern Shore and Western Shore)		
Northern Mexican gartersnake (<i>Thamnophis eques megalops</i>)	PCE's are: 1) aquatic or riparian habitat, 2) up to 600 ft space on either side of bankful stage river w/ sufficient structural characteristics to support life-history functions 3) prey base of native amphibians and fish and 4) absence or low levels only of nonnative sunfish and catfish, bullfrogs and/or crayfish.	The proposed uses of dicamba DGA are not expected to overlap with stream or floodplain habitats	USFWS 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Federal Register V78(132): 41550—41608 http://www.gpo.gov/fdsys/pkg/FR-2013-07-10/pdf/2013-16520.pdf
Pawnee montane skipper (<i>Hesperia leonardus montana</i>)	The skippers occur in Colorado (Teller, Park, Jefferson, and Douglas) in dry, open, Ponderosa pine woodlands where the slopes are moderately steep with soils derived from Pikes Peak granite. The understory is limited in the pine woodlands.	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 1998. Recovery Plan for Pawnee Montane Skipper http://ecos.fws.gov/docs/recovery_plan/980921.pdf
Perdido Key beach mouse (<i>Peromyscus polionotus trissyllepsis</i>)	Coastal sand dunes & coastal scrub (USFWS 1987, p. 2); primary, secondary and interior or scrub dunes (USFWS 2007, p. 9)	The proposed dicamba DGA uses are not expected to overlap with sand dunes or coastal scrub.	USFWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/870812.pdf . USFWS. 2007. Perdido Key Beach Mouse (<i>Peromyscus polionotus trissyllepsis</i>), 5-Year Review: Summary and Evaluation. Panama City, Florida. 24 pp. Available online at: http://ecos.fws.gov/docs/five_year_review/doc1081.pdf .
Piping plover, Great Lakes watershed (<i>Charadrius melodus</i>)	The breeding habitat of the Great Lakes DPS of the piping plover is well defined by the Critical Habitat designation. Critical Habitat for this	The proposed dicamba DGA uses are not expected to overlap with sparsely vegetated sandy	USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3009.pdf

	DPS consists of approximately 200 miles of Great Lakes shoreline (extending 1640 ft inland) in 26 counties in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. Additional Critical Habitat for wintering populations of this DPS are in the southeastern United States and other areas that are outside the scope of this analysis (USFWS, 2000; USFWS, 2009, p.2).	shorelines or islands of the Great Lakes.	USFWS. 2000. Federal Register Notice http://ecos.fws.gov/docs/federal_register/fr3648.pdf
Piping plover, except Great Lakes watershed (<i>Charadrius melodus</i>)	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation. At inland lakes, they use barren to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).	The proposed dicamba DGA uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf
Puritan tiger beetle (<i>Cicindela puritana</i>)	The Maryland population (Calvert, Kent and Cecil Counties) is found in deep burrows, which they dig in sandy deposits on non-vegetated portions of the bluff face. The Connecticut population (Hartford; middlesex) is found in burrows among scattered	The proposed uses of dicamba DGA are not expected to overlap with beach habitats.	US FWS. 1993. Recovery Plan for the Puritan Tiger Beetle http://ecos.fws.gov/docs/recovery_plan/930929a.pdf

	herbaceous vegetation at the upper portions of sandy beaches and occasionally near the water's edge.		
Uncompahgre fritillary butterfly (<i>Boloria acrocnema</i>)	All colonies known to FWS occur in alpine environments, within large patches of snow willow and on northeast facing slopes.	The proposed uses of dicamba DGA are not expected to overlap with alpine habitats.	US FWS. 1994. Recovery Plan for <i>Boloria acrocnema</i> http://ecos.fws.gov/docs/recovery_plan/940317.pdf
Bluetail mole skink (<i>Eumeces egregius lividus</i>)	Habitat is primarily xeric (dry) upland communities above 30 m. The species relies on soils that have few root structures and sparse stands of vegetation but a large amount of debris providing shelter. These attributes are not consistent with cultivated row crop fields.	The proposed dicamba DGA use sites are not expected to provide appropriate habitat.	US FWS. 1999. Multi-Species Recovery Plan for South Florida: Bluetail Mole Skink. United States Fish and Wildlife Service. http://www.fws.gov/verobeach/MSRPPDFs/BluetailMoleSkink.pdf
Bog (=Muhlenberg) turtle (<i>Clemmys muhlenbergii</i>)	Wetland habitats including dry, wet, and periodically flooded micro-habitats and are often interspersed with agricultural areas and livestock grazing.	The proposed dicamba DGA uses are not expected to overlap with aquatic habitats.	US FWS. 2001. Recovery Plan for the Bog Turtle. http://ecos.fws.gov/docs/recovery_plan/010515.pdf
Cheat Mountain salamander (<i>Plethodon nettingi</i>)	This species occurs in red spruce and mixed deciduous forests. Microhabitats have high humidity, moist soil and cool temperatures. The forest floor is (usually) covered with liverwort (<i>Bazzania trilobata</i>) and contains rocks.	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 1991. Cheat Mountain salamander (<i>Plethodon nettingi</i>) recovery plan. United States Fish and Wildlife Service. http://ecos.fws.gov/docs/recovery_plan/910725.pdf USFWS. 2009. Cheat Mountain salamander (<i>Plethodon nettingi</i>) 5-year review: summary and evaluation. http://ecos.fws.gov/docs/five_year_review/doc3267.pdf .

Chiricahua leopard frog (<i>Rana chiricahuensis</i>)	Adults are primarily aquatic and found in a variety of aquatic habitats including cienegas, springs, pools, cattle tanks, lakes, reservoirs, streams, and rivers. The species also requires permanent or semi-permanent pools for breeding, water characterized by low levels of contaminants and moderate pH, and may be excluded or exhibit periodic die-offs where a pathogenic chytridiomycete fungus is present	The proposed uses of dicamba DGA are not expected to overlap with aquatic habitats.	US FWS. 2007. Chiricahua leopard frog (<i>Rana chiricahuensis</i>) final recovery plan. http://ecos.fws.gov/docs/recovery_plan/070604_v3.pdf .
Desert tortoise (<i>Gopherus agassizii</i>)	<p>The Mojave population of the desert tortoise is most commonly found within the desert scrub vegetation type, primarily in creosote bush-scrub vegetation, but also in succulent scrub, cheesebush scrub, blackbush scrub, hopsage scrub, shadscale scrub, microphyll woodland, and Mojave saltbush-allscale scrub. Within the desert microphyll woodland, the desert tortoise occurs in blue palo verde-ironwood-smoke tree woodland. The desert tortoise also occurs in scrub-steppe vegetation types of the desert and semidesert grassland complex.</p> <p>Within these vegetation types, desert tortoises potentially can survive and reproduce where their basic habitat requirements are met. These requirements include a sufficient amount and quality of forage species; shelter sites for protection from predators and environmental extremes; suitable substrates for burrowing, nesting, and overwintering; various plants for shelter; and adequate area for movement, dispersal, and gene flow.</p>	The proposed uses of dicamba DGA are not expected to overlap with the scrub-steppe vegetation types of the desert and semidesert grassland complex (Mojave population) or the steep rocky slopes, drought resistant scrub and tree habitat (Sonoran population) and the agricultural fields where it will be used are not expected to provide the soil and understory requirements of this species.	<p>US FWS, 2011. Revised Recovery Plan for the Mojave Population of the Desert Tortoise (<i>Gopherus agassizii</i>).</p> <p>http://ecos.fws.gov/docs/recovery_plan/RRP%20for%20the%20Mojave%20Desert%20Tortoise%20-%20May%202011_1.pdf</p> <p>US FWS, 1994. Determination of Critical Habitat for the Mojave Population of the Desert Tortoise.</p> <p>http://ecos.fws.gov/docs/federal_register/fr2519.pdf</p>

	In the Sonoran Desert, tortoises tend to inhabit bajadas (slopes at the base of a mountain) and steep, rocky slopes and are not common in the valleys) and are also found in the Sinaloa thornscrub, where vegetation is dominated by drought-resistant shrubs and deciduous trees.		
Jemez Mountains Salamander (<i>Plethodon neomexicanus</i>)	The strictly terrestrial Jemez Mountains salamander predominantly inhabits mixed-conifer forest, consisting primarily of Douglas fir, blue spruce, Engelman spruce, white fir, limber pine, Ponderosa pine, Rocky Mountain maple, and aspen (<i>Populus tremuloides</i>). Pure stands of Ponderosa pine, fir and aspen stands, and high-elevation meadows are not considered ideal habitats but species have been known to occur in such places.	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS species life-history profile. ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=D019#lifeHistory
Red-cockaded entire woodpecker (<i>Picoides borealis</i>)	Habitat: Forest, Savannah (open pine woodlands and savannas with large old pines) (US FWS 2003, p. x) Habitat size (home range): 116 – 357 acres (US FWS 2003, p. 49)	Proposed dicamba DGA uses are not expected to overlap with forest or savannah.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf
Reticulated flatwoods salamander (<i>Ambystoma bishopi</i>)	Aquatic and terrestrial. Longleaf pine ecosystems (Coastal Plain in what were historically longleaf pine-wiregrass flatwoods and savannas). Adults spend most of their lives underground.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2009. Federal Register, vol. 74, No. 26. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and

	Breed in small, isolated ephemeral ponds. (USFWS 2009)		reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
Rice rat (<i>Oryzomys palustris natator</i>)	Found in scrub and fringe mangrove communities. Live on small wetland islands, 23 ha.	The proposed uses of dicamba DGA are not expected to overlap with wetland or scrubland habitats.	US FWS. 1999. South Florida multiple-species recovery plan. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf http://ecos.fws.gov/docs/recovery_plan/140903.pdf
Roseate tern (<i>Sterna dougallii dougallii</i>)	Rocky offshore islands with sparse vegetation; although Northeastern Roseate tern nest under vegetation or some other shelter (USFWS 1993, p. 3).	The proposed dicamba DGA uses are not expected to overlap with offshore islands.	USFWS 1993. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/930924_v2.pdf
Sand skink (<i>Neoseps reynoldsi</i>)	Habitat is primarily xeric (dry) upland communities between high pine and scrub.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or high pine wooded habitats.	US FWS. 1999. Multi-Species Recovery Plan for South Florida: Sand Skink. United States Fish and Wildlife Service. http://www.fws.gov/verobeach/MSRPPDFs/SandSkink.pdf
Schaus swallowtail butterfly (<i>Heraclides aristodemus ponceanus</i>)	Occur exclusively in subtropical dry forests (hardwood hammocks) including areas that were formerly cleared and farmed, but have since regrown.	The proposed uses of dicamba DGA are not expected to overlap with forested areas or areas that were farmed but have since regrown.	US FWS. 1999. South Florida Multi-Species Recovery Plan: Schaus Swallowtail Butterfly. http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Shenandoah salamander (<i>Plethodon shenandoah</i>)	The species is found in forests, and dry, rocky, talus slopes, of mountains, generally facing north at elevations greater than 800 m in Shenandoah National park.	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 1994. Shenandoah salamander (<i>Plethodon shenandoah</i> Highton and Worthington) recovery plan. http://ecos.fws.gov/docs/recovery_plan/940929a.pdf

<p>Sonora tiger Salamander (<i>Ambystoma tigrinum stebbinsi</i>)</p>	<p>Found in standing water, grassland and oak woodland terrestrial habitats as well as human-constructed ponds or cattle tanks Terrestrial adults most likely spend time in mammal burrows or buried in the ground</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with aquatic, grassland or woodland habitats.</p>	<p>US FWS. 2002. Sonora tiger salamander recovery plan. http://ecos.fws.gov/docs/recovery_plan/020924.pdf.</p>
<p>Southeastern beach mouse (<i>Peromyscus polionotus niveiventris</i>)</p>	<p>Located on coastal sand dunes & coastal scrub, frontal (primary and secondary) and scrub dunes (including oak scrub), and inland habitats such as coastal strand woody plants. Habitat size is approximately 80.5 km, with young beach mice moving an average of 432 m (1,415 ft) before establishing a home range.</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with scrubland or woodland habitats</p>	<p>US FWS. 2008. Southeastern Beach Mouse (<i>Peromyscus polionotus niveiventris</i>), 5-year Review: Summary and Evaluation. Jacksonville, Florida. 36 pp. http://ecos.fws.gov/docs/five_year_review/doc1888.pdf. US FWS. 1993. Recovery Plan for the Anastasia Island and Southeastern Beach Mouse. Atlanta Georgia. 30 pp. http://ecos.fws.gov/docs/recovery_plan/930923b.pdf.</p>
<p>Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)</p>	<p>Breeding: Forested wetlands or scrub-shrub wetlands-dense riparian habitat of rivers, swamps, wetlands, lakes (USFWS 2002, p. iv). Wintering: brushy savanna edges, second growth, shrubby clearings and pastures, woodlands near water (USFWS 2002, p. iv).</p>	<p>Recommend off-field status for row crop agriculture. According to the Critical Habitat designation document (USFWS 2013) essential characteristics for southwestern will flycatcher habitat include riparian areas for flowing stream that support expansive riparian vegetation areas. Riparian trees and understory species are viewed as essential elements of flycatcher habitat. Row crop soy and corn are monocultures of non-riparian vegetation</p>	<p>USFWS 2002. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plans/2002/020830c.pdf USFWS. 2013. Designation of Southwestern Willow Flycatcher Critical Habitat: Final Rule. Federal Register Vol. 78 No.2.</p>

		and consequently not suitable habitat for this species.	
Spruce-fir moss spider (<i>Microhexura montivaga</i>)	Typical habitat appears to be associated with moist, well-drained moss mats growing on rocks and boulders in well-shaded situations in mature high-elevation conifer forests dominated by Fraser fir, <i>Abies fraseri</i> , often with scattered red spruce, <i>Picea rubens</i> . (US FWS 1998, p. iii)	The proposed dicamba DGA uses are not expected to overlap with high-elevation conifer forests.	US FWS, 1998, Recovery Plan. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
St. Andrew beach mouse (<i>Peromyscus polionotus peninsularis</i>)	Found on coastal dunes. Range of species is approximately 46 km.	The proposed uses of dicamba DGA are not expected to overlap with coastal dune habitats	US FWS. 2010. Recovery plan for St. Andrews Beach Mousse (<i>Peromyscus polionotus peninsularis</i>). United States Fish and Wildlife Service. http://ecos.fws.gov/docs/recovery_plan/20110104_SABM_recovery_plan_FINAL.pdf
Stock Island tree snail (<i>Orthalicus reses</i> (not incl. <i>nesodryas</i>))	Survive best in hardwood hammocks with smooth-barked native trees that support relatively large amounts of lichen and algae. Species is entirely arboreal except when they move to the forest floor for nesting and traveling.	The proposed uses of dicamba DGA are not expected to overlap with forested habitats	US FWS. 1999. Multi-Species Recovery Plan for South Florida: Stock Island Tree Snail. http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
California least tern (<i>Sterna antillarum browni</i>)	Coastal lagoons and estuaries (freshwater marshes, lakes, lagoons, beaches, and estuary areas. Additionally can be found in man-made habitats such as airports and land fields.	This species feeds exclusively on fish and are therefore not expected to be exposed to dicamba DGA.	US FWS. 1985. Revised California Least Tern Recover Plan. http://ecos.fws.gov/docs/recovery_plan/850927_w%20signature.pdf US FWS. 2006. California Least Tern (<i>Sterna antillarum browni</i>) 5-Year Review and Evaluation: http://ecos.fws.gov/docs/five_year_review/doc775.pdf
Florida grasshopper sparrow (<i>Ammodramus savannarum floridanus</i>)	Habitat is large (greater than 50 ha), treeless, and relatively poorly-drained grasslands that have a history of frequent fires. Average	The proposed dicamba DGA use sites are not expected to provide appropriate fire influenced habitat.	US FWS. 1999. South Florida multiple-species recovery plan.

	and maximum habitat size are 1.8 and 4.82 ha, respectively. The species requires relatively large open areas maintained by periodic fires. An analogy to row cropped areas is the effect of overgrazed grasslands with poorly structured and inappropriately dispersed habitat stands. These areas are not capable of maintaining population of the species. It is reasonable to expect that row-cropped agricultural fields provide even less suitable habitat than the already unsuitable overgrazed pasture lands.		http://ecos.fws.gov/docs/recovery_plan/140903.pdf http://www.fws.gov/verobeach/MSRPPDFs/FloridaGrasshopperSparrow.pdf
Masked bobwhite (quail) (<i>Colinus virginianus ridgwayi</i>)	Open savanna grassland within dry-tropic scrub. These birds are associated with weedy bottom lands, grassy and herb-strewn valleys, and forb-rich plains.	<ul style="list-style-type: none"> - Only known US population is in captive flock on the BANWR. Attempts to release the birds back to the wild have been unsuccessful and evidence of wild populations does not exist. "As of 2001, occurrence of wild masked bobwhite is nearly completely restricted to the captive flock occurring on the BANWR." - Habitat requirements include 15-30% scrub/shrub cover and a diverse range of grass/forb species (at least 10-12 different species). They do not use monocultures, even if it is an attractive food source. "Monocultures of even such important food species as vine mesquite grass and Johnson grass were avoided". - Once home ranges are established they do not leave their boundaries. - While this species has been seen in rangeland it has never been associated with row 	<p>US FWS. 1995. Masked Bobwhite Quail Recovery Plan.</p> <p>http://ecos.fws.gov/docs/recovery_plan/950421.pdf</p>

		crops (most likely because of the monoculture).	
Yuma clapper rail (<i>Rallus longirostris yumanensis</i>)	Salt to brackish water marshes, mangrove swamps, other tidal wetlands. Found in the lower Colorado River (LCR) and tributaries (Virgin River, Bill Williams River, lower Gila River [LGR]) in Arizona, California, Nevada; the Salton Sea in California; and the Cienegade Santa Clara and Colorado River Delta in Mexico	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1983. Yuma Clapper Rail Recovery Plan (<i>Rallus longirostris yumanensis</i>) DRAFT FIRST REVISION http://ecos.fws.gov/docs/recovery_plan/Draft%20Yuma%20Clapper%20Rail%20Recovery%20Plan,%20First%20Revision.pdf
Hualapai Mexican vole (<i>Microtus mexicanus hualpaiensis</i>)	Woodland forest types containing grasses and grass-sedge habitats. associated with moist grass-sedge areas along permanent or semi-permanent waters fed by springs or seeps in either open forest or chapparal. Good cover of grasses, sedges and forbs is characteristic of this waterside vole habitat, which is usually found in narrow bands paralleling the water	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 1991. Hualapai Mexican Vole Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910819.pdf
<u>Tern, least interior pop. (<i>Sterna antillarum</i>)</u>	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting	The proposed dicamba DGA uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf

	occurs along river banks (US FWS, 1990, p. 20).		
Mount Graham red squirrel (<i>Tamiasciurus hudsonicus grahamensis</i>)	Pinaleño Mountains in the Coronado National Forest. The species inhabits upper elevation, mature to old-growth associations in mixed conifer and spruce-fir above approximately 2,425 m (8,000 ft). The majority of surviving red squirrels now occur at lower elevations in the mixed-conifer forest that extend well down the mountain	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 2011. Draft Mount Graham Red Squirrel Recovery Plan, First Revision http://ecos.fws.gov/docs/recovery_plan/FR00000388%20Draft%20Mount%20Graham%20Red%20Squirrel%20Recovery%20Plan%20First%20Revision%20Final.pdf
Preble's meadow jumping mouse (<i>Zapus hudsonius preblei</i>)	Heavily vegetated riparian habitats. Water source (creeks, streams, rivers), consisting of shrubs, forbs, grasses, woodland, and herbaceous species and can occur upland beyond floodplain.	Habitat for the PMJM is listed as “well developed riparian vegetation, adjacent relatively undisturbed grasslands, and a nearby water source”. The mouse may travel up to 100m upland from the riparian zone but the habitat needs to be undisturbed grasslands. PCEs for the mouse include “riparian corridors... and additional adjacent floodplain and upland habitat with limited disturbance (including hayed fields, grazed pastures, other agricultural lands that are not plowed or disked regularly, etc)”	(US FWS. 1998. Endangered and Threatened Wildlife and Plants; Final Rule to List the Preble’s Meadow Jumping Mouse as a Threatened Species. http://ecos.fws.gov/docs/federal_register/fr3260.pdf US FWS. 2007. Endangered and Threatened Wildlife and Plants; Revised Proposed Rule to Amend the Listing for the Preble’s Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>) to Specify Over What Portion of Its Range the Subspecies is Threatened; Proposed Rule. http://ecos.fws.gov/docs/five_year_review/doc1719.pdf
New Mexican ridge-nosed rattlesnake (<i>Crotalus willardi obscurus</i>)	Mountains, elevated plateaus, and pine-oak vegetation	The proposed dicamba DGA uses are not expected to overlap with woodland habitats.	(US FWS. 1985. Recovery Plan for the New Mexican Ridge-Nosed Rattlesnake. http://ecos.fws.gov/docs/recovery_plan/850322.pdf
Wood stork (<i>Mycteria americana</i>)	Freshwater and estuarine Wetlands. (US FWS 1986, p. iii). Wood storks breed in FL, GA and SC. They migrate south in winter (US FWS 1986, p. 2).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970127.pdf USFWS. 2006. Five year Review.

	Require a mosaic of wetlands with varying climatological and seasonal conditions around colonies and within the wintering habitat in the coastal plain of the Southeast U.S. (US FWS 2006, p. 12).		http://ecos.fws.gov/docs/five_year_review/doc1115.pdf
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Species	Habitat	Rationale	Source
Aquatic Organisms			
Alamosa springsnail (<i>Tryonia alamosae</i>)	The Alamosa springsnail is found mainly where minor rivulets flow out of the main channel downstream of the springhead. In these situations, there is a mat of watercress and filamentous green algae over water 1—2 inches deep flowing over fine gravel and sand among rhyolitic cobbles and rocks. The species is found in slow current on gravel and among vegetation, and is most abundant where an organic film covers the pebbles and cobbles.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1994. Socorro and Alamosa Springsnail Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940831b.pdf
Apache trout (<i>Oncorhynchus apache</i>)	Apache trout currently exist mainly in headwater areas upstream from natural and artificial barriers. This environment is subject to extreme variations in both temperature and flow.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2009. Apache Trout (<i>Oncorhynchus apache</i>) Recovery Plan, Second Revision http://ecos.fws.gov/docs/recovery_plan/090903.pdf
Arkansas River shiner (<i>Notropis girardi</i>)	Wilde et al. (2000) found no obvious selection for or avoidance of any particular habitat type (i.e., main channel, side channel, backwaters, and pools) by Arkansas River shiner. Arkansas River shiners did tend to select side channels and backwaters slightly more than expected based on the availability of these habitats (Wilde et al. 2000). Likewise, they appeared to make no obvious selection for, or avoidance of, any particular substrate type. Substrates (i.e., the river bed) in the Canadian River in New Mexico and Texas were predominantly sand, however, the Arkansas River shiner was observed to occur over silt slightly more than expected based on the availability of this substrate (Wilde et al. 2000) ;	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2005. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/recovery_plan/950830.pdf

	<p>preferred habitat for the Arkansas River shiner is the mainstem of larger plains rivers... historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin (Gilbert 1980). Adults are uncommon in quiet pools or backwaters lacking streamflow, and almost never occurred in habitats having deep water and bottoms of mud or stone (Cross 1967) (US FWS 2005).</p>		
<p><u>Bean, Cumberland (pearly mussel) (Villosa trabalis)</u></p>	<p>Restricted typically to tributary streams of the upper reaches of the Tennessee and Cumberland Rivers. This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, <i>V. trabalis</i> is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species (US FWS 2010, p. 7).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 2010. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc3244.pdf</p>
<p><u>Bean, purple (Villosa perpurpurea)</u></p>	<p>Inhabits small headwater streams (Neves 1991) to medium-sized rivers (Gordon 1991). It is found in moderate to fast-flowing riffles with sand, gravel, and cobble substrates (Neves 1991) and rarely occurs in deep pools or slack water (Ahlstedt 1991a). It is sometimes found out of the main current adjacent to water-willow beds and under flat rocks (Ahlstedt 1991a,</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf</p>

	Gordon 1991) (US FWS 2004, p. 19).		
Bean, rayed (<i>Villosa fabalis</i>)	The rayed bean is generally known from smaller, headwater creeks, but occurrence records exist from larger rivers (Cummings and Mayer 1992, p. 142; Parmalee and Bogan 1998, p. 244). They are usually found in or near shoal or riffle (short, shallow length of stream where the stream flows more rapidly) areas, and in the shallow, wave-washed areas of glacial lakes, including Lake Erie (West et al. 2000, p. 253). In Lake Erie, the species is generally associated with islands in the western portion of the lake. Preferred substrates typically include gravel and sand. The rayed bean is oftentimes found among vegetation (water willow (<i>Justicia americana</i>) and water milfoil (<i>Myriophyllum</i> sp.)) in and adjacent to riffles and shoals (Watters 1988b, p. 15; West et al. 2000, p. 253) (US FWS 2012, p. 8633).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS 2012 - Federal Register Determination of Endangered Status. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
Beautiful shiner (<i>Cyprinella formosa</i>)	Found in small to medium streams with sand, gravel, and rock bottoms below 4500 ft elevation and is also found in artificial ponds.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species fact sheet http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Beautiful%20Shiner.pdf
Birdwing pearlymussel (<i>Lemiox rimosus</i>)	The birdwing pearlymussel inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins. The species is commonly found near riffles on sand and gravel substrates with firm rubble. Individuals have been found in waters ranging from six to seven feet deep.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page http://ecos.fws.gov/docs/life_histories/F00I.html
<u>Blackside dace</u> (<u>Phoxinus</u>)	This species inhabits cool, small, upland streams with moderate flows. The fish is	The proposed dicamba DGA uses are not expected to overlap	USFWS. 1988. Recovery Plan.

cumberlandensis)	generally associated with undercut stream banks and large rocks, and it is usually found within well-vegetated watersheds with good riparian vegetation (US FWS 1988, p. 6).	with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/880817.pdf
Bonytail chub (<i>Gila elegans</i>)	This is a freshwater mainstream, big-river fish. It is also found in pools and cddics, with gravel, rocky, silt and/or silt-boulder substrates. The bonytail chub has also been found in rocky shoals and shorelines, and is adapted for swift, strong currents.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2002. Bonytail (<i>Gila elegans</i>) Recovery Goals. http://ecos.fws.gov/docs/recovery_plan/060727c.pdf
Canada lynx (<i>Lynx canadensis</i>)	PCE: Boreal forest landscapes with large populations of snowshoe hares. Distribution and abundance of prey and microclimate influence movement, hunting behavior, and den and resting site locations. Areas with dense cover.	The proposed dicamba DGA uses are not expected to overlap with boreal forests. The lynx's prey, snowshoe hares, also do not overlap with the proposed dicamba DGA use sites.	USFWS. 2014. Federal Register Notice: Designation of Critical Habitat http://www.gpo.gov/fdsys/pkg/FR-2014-09-12/pdf/2014-21013.pdf
Chihuahua chub (<i>Gila nigrescens</i>)	Deep pools, undercut banks, or over-hanging vegetation. Adults are in lateral scour pools, beneath undercut banks, under solid objects (e.g., logs, boulders) and/or adjacent to moderate to fast flowing water in small to medium sized streams. The species also utilizes corner and backwater pools containing large woody debris (also used) with extensive cover composed of organic debris or root wads of large trees. Pools are 1-2 m deep with water velocity <15 cm/sec and small grained substrates (sand to pea-sized). Juveniles are found in shallower water with or without cover in small and medium sized streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1986. Chihuahua Chub Recovery Plan http://ecos.fws.gov/docs/five_year_review/doc4325.pdf US FWS. 2007. http://ecos.fws.gov/docs/five_year_review/doc4325.pdf
Chipola slabshell (<i>Elliptio chipolaensis</i>)	The Chipola slabshell inhabits silty sand substrates of large creeks and the main channel of	The proposed dicamba DGA uses are not expected to overlap with rivers,	USFWS 2003. Recovery Plan for 7 mussels. Page 43.

	the Chipola River in slow to moderate current (Williams and Butler 1994). Specimens are generally found in sloping bank habitats. Nearly 70 percent of the specimens found during the status survey were associated with a sandy substrate (Brim Box and Williams 2000).	streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Choctaw bean (<i>Villosa choctawensis</i>)	It is found in medium creeks to medium rivers in stable substrates of silty sand to sandy clay with moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61669
Chupadera springsnail (<i>Pyrgulopsis chupaderae</i>)	Chupadera springsnail has been documented on two hillsides where groundwater discharges flow through volcanic gravels containing sand, mud, and aquatic plants with water temperatures ranging from 15 to 25 degrees Celsius (°C) (59 to 77 degrees Fahrenheit (°F)) and velocities ranging from 0.01 to 0.19 meters per second (m/s) (0.03 to 0.6 feet per second (ft/s))	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2012. Determination of Endangered Status for the Chupadera Springsnail and Designation of Critical Habitat: Final rule. http://www.gpo.gov/fdsys/pkg/FR-2012-07-12/pdf/2012-16988.pdf
Clubshell (<i>Pleurobema clava</i>)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf
Colorado pikeminnow (=squawfish) (<i>Ptychocheilus lucius</i>)	The adult Colorado pikeminnow requires pools, deep runs, and eddy habitats maintained by high spring flows.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2002. Colorado Pike Minnow (<i>Ptychocheilus lucius</i>) Recovery Goals http://ecos.fws.gov/docs/recovery_plan/020828b.pdf

Combsshell, Cumberlandian (<i>Epioblasma brevidens</i>)	This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse, sand, gravel, cobble, and boulders. It is not associated with small stream habitats and tends not to extend as far upstream in tributaries (US FWS 2004, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
Cracking pearly mussel, (<i>Hemistena lata</i>)	The cracking pearly mussel has undergone a substantial range reduction. It was historically distributed in the Ohio, Cumberland, and Tennessee River systems. The species has been extirpated throughout much of its range. It was last collected from Mussel Shoals, an 85 km reach of the Tennessee River in Alabama, prior to 1925 and is presumed to be extirpated from the shoal. It is presently known to survive at only a few shoals in the Clinch and Powell Rivers in Tennessee and Virginia, and it has likely been reduced to only three viable populations in these systems. The species possibly survives in the Green River, Kentucky, and below Pickwick Reservoir in the Tennessee River, Tennessee as well	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F01X.html
Desert pupfish (<i>Cyprinodon macularius</i>)	Habitats have included clear, shallow waters with soft substrate associated with cienegas, springs, streams, margins of larger lakes and rivers, shoreline pools, and irrigation drains and ditches below 1,585 meters (5,200 feet) in elevation. Known natural populations are now restricted to two streams tributary, and in shoreline pools and irrigation drains of, the Salton Sea in California	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2010. Desert Pupfish (<i>Cyprinodon macularius</i>) 5-Year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc3573.pdf
Diamond Darter (<i>Crystallaria cincotta</i>)	Adult diamond darters and crystal darters typically have been captured in riffle-pool transition areas with predominately (greater than	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2013. Designation of Critical Habitat for the Diamond Darter (<i>Crystallaria cincotta</i>); Final Rule

	20 percent each) sand and gravel substrates.		http://www.gpo.gov/fdsys/pkg/FR-2013-08-22/pdf/2013-20449.pdf
Dromedary pearlymussel, (<u>Dromus dromas</u>)	This species is most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
Duskytail darter, (<u>Etheostoma percnurum</u>)	This species inhabits rocky areas in gently flowing shallow pools and runs in large creeks and moderately large rivers in the Tennessee and Cumberland River Systems (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/duskytaildarter_RP.pdf
Dwarf wedgemussel (<i>Alasmidonta heterodon</i>)	The dwarf wedge mussel lives on muddy sand, sand, and gravel bottoms in creeks and rivers of varying sizes, in areas of slow to moderate current and little silt deposition.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1993. <u>Dwarf Wedge Mussel</u> recovery plan. Page 3.
Fanshell (<i>Cyprogenia stegaria</i>)	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf
Fat three-ridge (mussel) (<i>Amblema neislerii</i>)	The fat threeridge inhabits the main channel of small to large rivers in slow to moderate current. Substrate used by this mussel varies from gravel to cobble to a mixture of sand and sandy mud (Williams and Butler 1994). Brim Box and Williams (2000) found 60 percent of the specimens were located in a sandy silt substrate.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Finback whale, (<i>Balaenoptera physalus</i>)	Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar	The proposed dicamba DGA uses are not expected to	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm

	latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally.	overlap with coastal waters.	
Finerayed pigtoed (<i>Fusconaia cuneolus</i>)	This species is typically a riffle species that inhabits ford and shoal areas in free-flowing streams of moderate gradient (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/fine%20rayed%20recovery%20plan.pdf
Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
Fuzzy pigtoe (<i>Pleurobema strodeanum</i>)	The fuzzy pigtoe is found in medium creeks to medium rivers in stable substrates of sand and silty sand with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshe</u> <u>ll, Round Ebonyshell,</u> <u>Southern Kidnevshell, and</u> <u>Choctaw Bean, and</u> <u>Threatened Species Status for the Tapered Pigtoe,</u> <u>Narrow Pigtoe, Southern</u> <u>Sandshell, and Fuzzy</u> <u>Pigtoe, and Designation of</u> <u>Critical Habitat: Final rule,</u> <u>Page 61673</u>
Gila chub (<i>Gila intermedia</i>)	Found in pools in smaller streams, cienegas, and artificial ponds. Highly secretive, adults prefer deeper, quieter waters in pools and eddies below riffles or runs, often remaining in cover from terrestrial vegetation, boulders, and fallen logs. Young-of-the year use the shallow margins of pools with aquatic vegetation or debris for cover. Older	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spc ode=E02P#lifeHistory

	juveniles may be found in higher velocity runs and riffles.		
Gila topminnow (incl. Yaqui) (<i>Poeciliopsis occidentalis</i>)	Shallow, warm, fairly quiet waters in ponds, cienegas, tanks, pools, springs, small streams, and the margins of larger streams. Dense mats of algae and debris along the margins of the habitats are an important component for cover and foraging. Substrates of organic muds and detritus also provide foraging areas.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E00C#lifeHistory
Gila trout (<i>Oncorhynchus gilae</i>)	clean gravel, moderate to high gradient in perennial mountain streams	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2003. Gila trout recovery plan (third revision). http://ecos.fws.gov/docs/recovery_plan/030910.pdf
Green blossom (pearly mussel) (<i>Epioblasma torulosa gubernaculum</i>)	Clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas <i>E. t. gubernaculum</i> was restricted to the high gradient rivers of the Appalachian mountains and the Cumberland Plateau	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1983. Recovery Plan Green-blossom Pearly Mussel <i>Epioblasma (=Dysnomia) torulosa gubernaculum</i> . http://ecos.fws.gov/docs/recovery_plan/060228.pdf
Greenback Cutthroat trout (<i>Oncorhynchus clarki stomias</i>)	Require clear, swift -flowing mountain streams with cover such as overhanging banks and vegetation. Riffle areas are used for spawning. Juveniles tend to shelter in shallow backwaters until large enough to fend for themselves in the mainstream.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life-history page. http://ecos.fws.gov/docs/life_histories/E00F.html
Green sea turtle (<i>Chelonia mydas</i>)	Green turtles are primarily restricted to tropical and subtropical waters. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found from Massachusetts to Texas and in the U.S. Virgin Islands and Puerto Rico...Seagrasses are the principal dietary component of juvenile and adult green turtles throughout the Wider Caribbean region	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

	(Bjorndal, 1995). (NMFS, NOAA 1998, p. 46694)		
Gulf moccasinshell (<i>Medionidus penicillatus</i>)	The Gulf moccasinshell inhabits the channels of small to medium-sized creeks to large rivers with sand and gravel or silty sand substrates in slow to moderate currents (Williams and Butler 1994; Garner, pers. comm. 2003).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Gulf sturgeon, (<i>Acipenser oxyrinchus desotoi</i>)	The Gulf sturgeon is an Anadromous fish which migrates from salt water into large coastal rivers to spawn and spend the warm months. The majority of its life is spent in fresh water (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950922.pdf
Hawksbill sea turtle, (<i>Eretmochelys imbricata</i>)	The hawksbill turtle occurs in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Coral reefs, like those found in the waters surrounding Mona and Monito Islands, are widely recognized as the primary foraging habitat of juvenile, subadult, and adult hawksbill turtles. This habitat association is directly related to the species' highly specific diet of sponges (Meylan, 1988). Hawksbills depend on coral reefs for food and shelter; therefore, the condition of reefs directly affects the hawksbill's well-being. (NMFS, NOAA 1998, p. 46695)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf
Hay's Spring amphipod (<i>Stygobromus hayi</i>)	The Hay's Spring amphipod inhabits a ground water outlet that feeds into a low gradient creek. Precise data on this habitat is lacking due to inaccessibility of habitat.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/K004.html
Humpback chub (<i>Gila cypha</i>)	Humpback chub are found in association with fast current, deep pool, and boulder habitats. They can occupy	The proposed dicamba DGA uses are not expected to overlap	US FWS. 1990. Recovery Plan for the Humpback Chub - 1990 2nd Revised Final Plan

	deep, swift riverine areas with large boulders and steep cliffs.	with aquatic environments.	http://ecos.fws.gov/docs/recovery_plan/900919c.pdf
Humpback whale (<i>Megaptera novaeangliae</i>)	<p>During migration, humpbacks stay near the surface of the ocean.</p> <p>While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.</p> <p>Humpback feeding grounds are in cold, productive coastal waters.</p>	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm
James spinymussel (<i>Pleurobema collina</i>)	This species lives in stream sites that vary in width from 10-75 feet and depth of 1/2 to 3 feet. It requires a slow to moderate water current with clean sand and cobble bottom sediments. The James spinymussel is limited to areas of unpolluted water, and may be more susceptible to competition from exotic clam species when its habitat is disturbed (Clark and Neves 1984, USFWS 1990).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F025.html
Kemp's ridley sea turtle, (<i>Lepidochelys kempii</i>)	This life history pattern is characterized by three basic ecosystem zones: (1) Terrestrial zone (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) Neritic zone - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) Oceanic zone - the vast open	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2011. Bi-national recovery plan for the kemp's ridley sea turtle. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

	ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2011, p. I-8)		
Koster's springsnail (<i>Juturnia kosteri</i>)	They inhabit springs and spring-fed wetland systems with variable water temperatures and slow to moderate water velocities over compact substrate (material on the bottom of the stream) ranging from deep organic silts to gypsum sands and gravel. Additionally, the habitat of Koster's springsnail consists of soft substrates of springs and seeps.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2011. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assimineia; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf
Leatherback sea turtle, (<i>Dermochelys coriacea</i>)	Leatherbacks are able to take advantage of a wide variety of marine ecosystems (reviewed by Saba 2013; see NOAA large marine ecosystem website: http://www.lme.noaa.gov/). Within these ecosystems, various oceanic features such as water temperature, downwelling, Ekman upwelling, sea surface height, chlorophyll-a concentration, and mesoscale eddies affect the presence of leatherbacks (Bailey et al. 2013; Benson et al. 2011). The physical characteristics observed within these marine ecosystems also affect the distribution and abundance of leatherback prey (reviewed by Saba 2013). (NMFS, NOAA 2013, p. 20-22).	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2013. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/090116.pdf
Lee County cave isopod (<i>Lirceus usdagalun</i>)	Found on the surfaces of small, submerged rocks and gravels in cave streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS 1997. Lee County Cave Isopod (<i>Lirceus usdagalun</i>) Recover Plan. http://ecos.fws.gov/docs/recovery_plan/970930c.pdf
Littlewing pearlymussel, (<i>Pegias fabula</i>)	This species inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890922.pdf

	River basins (US FWS, 1989, p. 5).		
Little Colorado spinedace (<i>Lepidomeda vittata</i>)	Freshwater springs, streams and rivers. Tends to prefer pools, but occurs sporadically throughout the habitat. Predominately in open pools with undercut banks and/or boulders for cover. During periods of drought spinedace are believed to persist in springs and intermittent streambed pools; and during flooding they tend to distribute themselves throughout the stream. Found in pools with slow to moderate current adjacent to riffles; during spate conditions, in eddies lateral to the current.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1997. Little Colorado River Spinedace Recovery Plan http://ecos.fws.gov/docs/recovery_plan/980109.pdf Federal Register/Vol. 52, No. 179. September 16, 1987, Little Colorado Spinedace Critical Habitat. http://ecos.fws.gov/docs/federal_register/fr1325.pdf
Loach minnow (<i>Tiaroga cobitis</i>)	Inhabits turbulent waters over gravel and/or cobble bottoms in riffles of mainstream rivers, fast-flowing streams, and tributaries. Due to a reduced gas bladder the species is restricted almost exclusively to a bottom-dwelling habit, swimming in swift water is only for brief moments. Most habitat is relatively shallow and the fish is found at elevations up to 2200 meters.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1991. Loach Minnow Recovery Plan http://ecos.fws.gov/docs/recovery_plan/910930f.pdf
Loggerhead sea turtle, Northwest Atlantic DPS (<i>Caretta caretta</i>)	The three basic ecosystems in which loggerheads live are the: 1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur. 2. Neritic zone - the nearshore marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters. The neritic zone generally includes the continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS. NOAA. 2009. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

	neritic zone conventionally extends to areas where water depths are less than 200 meters. 3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2009, p. I-20)		
Madison Cave isopod (<i>Antrolana lira</i>)	Flooded limestone caves beneath the Great Valley of Virginia and West Virginia where it swims freely through calcite-saturated waters of deep karst aquifers	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life-history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=K008#lifeHistory
Maryland darter (<i>Etheostoma sellare</i>)	Found in swiftly flowing streams (with rocky, rubble and gravel substrates), and prefers rock crevices and similar shelters in clean, well-oxygenated, parts of those streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	USFWS. 1985. Maryland darter revised recovery plan. http://ecos.fws.gov/docs/recovery_plan/851017.pdf
Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)	The Mexican long-nosed bat has evolved an apparent mutualistic association with <i>Agave</i> sp. The bat is principally a nectar feeder, foraging on the flowers of <i>Agave</i> , and in some minor proportions consuming the pollen, fruits, and any incidental insects associated with the flowers. The bats occupy mid- to high-elevational desert scrub, open conifer-oak woodlands, and pine forest habitats in the Upper Sonoran and Transition Life Zones.	The proposed dicamba DGA uses are not expected to overlap with the desert scrub, open conifer-oak woodlands and pine forest habitats of the bat. The bat's major resource need, <i>Agave</i> plants are not expected to be on soybean and cotton fields.	USFWS. 1994. Recovery Plan. https://ecos.fws.gov/docs/recovery_plan/940908.pdf
Monkeyface, Appalachian (pearly mussel) (<i>Quadrula sparsa</i>)	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709.pdf

<u>Monkeyface,</u> <u>Cumberland</u> <u>(pearlymussel)</u> <u>(Quadrula</u> <u>intermedia)</u>	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709b.pdf
Narrow pigtoe (<i>Fusconaia escambia</i>)	It is found in medium creeks to medium rivers, in stable substrates of sand, sand and gravel, or silty sand, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of</u> <u>Endangered Species Status</u> <u>for the Alabama Pearlshe</u> <u>Round Ebonyshell,</u> <u>Southern Kidneyshell, and</u> <u>Choctaw Bean, and</u> <u>Threatened Species Status</u> <u>for the Tapered Pigtoe,</u> <u>Narrow Pigtoe, Southern</u> <u>Sandshell, and Fuzzy</u> <u>Pigtoe, and Designation of</u> <u>Critical Habitat: Final rule.</u> <u>Page 61671</u>
Noel's Amphipod (<i>Gammarus desperatus</i>)	Inhabits shallow, cool, well-oxygenated waters of streams, ponds, ditches, sloughs, and springs.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2010. Noel's amphipod (<i>Gammarus desperatus</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3600.pdf
North Atlantic Right Whale (<i>Eubalaena glacialis</i>)	The North Atlantic right whale primarily occurs in coastal or shelf waters, but may go into deeper waters. (NMFS 2004, p. v)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS. 2004. Recovery plan for the north Atlantic right whale (<i>Eubalaena glacialis</i>). Available online at: http://ecos.fws.gov/docs/recovery_plan/whale_right_northatlantic.pdf
Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)	The Ochlockonee moccasinshell inhabits large creeks and the Ochlockonee River main stem in areas with current. Typical substrates are sand with some gravel (Williams and Butler 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Oval pigtoe (<i>Pleurobema pyriforme</i>)	The oval pigtoe occurs in small to medium-sized creeks to small rivers	The proposed dicamba DGA uses are not expected to	USFWS 2003. Recovery Plan for 7 mussels. Page 43.

	where it inhabits silty sand to sand and gravel substrates, usually in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Stream channels appear to offer the best habitat for this species.	overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Oyster Mussel (<i>Epioblasma capsaeformis</i>)	This species is generally adapted to live in the gravel shoals of free-flowing rivers and streams (US FWS, 2004, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
Pecos assiminea snail (<i>Assiminea pecos</i>)	The Pecos assiminea requires saturated, moist soil at stream or spring-run margins and is found in wet mud or beneath mats of vegetation, usually within 1 inch (in) (2 to 3 centimeters (cm)) of flowing water. Spring complexes that contain flowing water create saturated soils that provide the specific habitat needed for population growth, sheltering, and normal behavior of the species. Although this snail seldom occurs immersed in water, the species cannot withstand permanent drying of springs or spring complexes. Consequently, wetland plant species are required to provide leaf litter (dead leaf material), shade, and appropriate microhabitat. Plant species such as <i>Scirpus americanus</i> (American three-square), <i>Eleocharis spp.</i> (spike rush), <i>Distichlis spicata</i> (inland saltgrass), and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule. Page 33039. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf

	<i>Juncus spp.</i> (rushes) provide the appropriate cover and shelter required by Pecos assiminea (NMDGF 2005, p. 13).		
Pecos bluntnose shiner (<i>Notropis simus pecosensis</i>)	Sandy substrate with low velocity flow, and at depths between 7-16 inches. Backwater, riffles, and pools are also used by younger individuals. Natural springs which are sources of continuous water flow also serve as habitat for <i>Notropis simus pecosensis</i> .	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E04F.html
Pecos gambusia (<i>Gambusia nobilis</i>)	<i>Gambusia nobilis</i> occurs abundantly in springheads and spring runs. Moderately abundant populations are also known from areas with little spring influence, but with abundant overhead cover, sedge covered marshes, and gypsum sinkholes. <i>G. nobilis</i> has been observed to occur from the surface to depths of three meter.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS ECOS Life Histories for the Pecos gambusia (<i>Gambusia nobilis</i>) http://ecos.fws.gov/docs/life_histories/E00V.html
Pink Mucket (pearly mussel) (<i>Lampsilis abrupta</i>)	<p>The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10).</p> <p>The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the water is flowing (US FWS, 1985, p. 10).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf
Purple bankclimber (mussel)	The purple bankclimber inhabits small to large river channels in slow to	The proposed dicamba DGA uses are not expected to	USFWS 2003. Recovery Plan for 7 mussels. Page 43.

<i>(Elliptoides sloatianus)</i>	moderate current over sand or sand mixed with mud or gravel substrates (Williams and Butler 1994).	overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)	Primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity. They have been reported in deep water runs up to 12 feet depth. "Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf
Razorback sucker (<i>Xyrauchen texanus</i>)	Fresh, large warm-water rivers: deep runs, eddies, backwaters, flooded off-channel. The species prefers shallow swift waters of mid-channel sandbars (less than 12ft deep) during the summer months, and slow runs, slack waters and eddies (2.0 to 4.6ft) in the winter.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2002. Razorback Sucker (<i>Xyrauchen texanus</i>) Recovery Goals. http://ecos.fws.gov/docs/recovery_plan/060727c.pdf
Riffleshell, northern (<i>Epioblasma torulosa rangiana</i>)	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf
Rio Grande silvery minnow (<i>Hybognathus amarus</i>)	In general, the species is most often found in areas of low or moderate water velocity (e.g., eddies formed by debris piles, pools, backwaters, and embayments), and is rarely found in habitats with high	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1999. Rio Grande Silvery Minnow Recovery Plan (<i>Hybognathus amarus</i>) First Revision http://ecos.fws.gov/docs/recovery_plan/022210_v2.pdf

	water velocities, such as main channel runs, which are often deep and swift.		
Roanoke logperch (<i>Percina rex</i>)	The Roanoke logperch occupies medium to large warm-water streams and rivers of moderate gradient with relatively unsilted substrata. During different phases of life history and season, every major riverine habitat is exploited by the logperch. Except in winter, all age classes are intolerant of moderately to heavily silted substrata. It is found in two river systems in Virginia-The Roanoke River drainage.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E01G.html
Round Ebonyshell (<i>Fusconaia rotulata</i>)	It occurs in small to medium rivers, typically in stable substrates of sand, small gravel, or sandy mud in slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668
Rough pigtoe, (<i>Pleurobema plenum</i>)	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and in sand and gravel substrates (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf
Roswell springsnail (<i>Pyrgulopsis roswellensis</i>)	Springs and spring-fed wetland systems with slow to moderate flowing water velocities, deep organic silts to limestone cobble and gypsum substrates and stable water levels.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2012. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf

Rough rabbitsfoot (<i>Quadrula cylindrica strigillata</i>)	Found in medium to large rivers with silt, sand gravel or cobble substrates, in eddies at edge of midstream currents. The species may be associated with macrophyte beds.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2004. Recovery Plan for Rough Rabbitsfoot (<i>Quadrula cylindrica strigillata</i>) http://ecos.fws.gov/docs/recovery_plan/040524.pdf
San Bernardino springsnail (<i>Pyrgulopsis bernardina</i>)	Associated with seeps, spring runs, and especially perennial spring systems that produce running water	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2012. Determination of Endangered Status for Three Forks Springsnail and Threatened Status for San Bernardino Springsnail Throughout Their Ranges and Designation of Critical Habitat for Both Species; Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-04-17/pdf/2012-8811.pdf
Shiny entire pigtoe, (<i>Fusconaia cor</i>)	This species is typically a riffle species, found along fords and shoals of clear, moderate to fast-flowing streams and rivers with stable substrate. It does not inhabit deep pools or impounded areas. This species is usually found well-buried in the substrate during most of the year and is more readily visible in early summer (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709d.pdf
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)	Shortnose sturgeon are found in rivers, estuaries, and the sea, but populations are confined mostly to natal rivers and estuaries. The species appears to be estuarine anadromous in the southern part of its range, but in some northern rivers it is	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS 1998. Final Recovery Plan for the Shortnose Sturgeon (<i>Acipenser brevirostrum</i>). Page 25. Available at: http://ecos.fws.gov/docs/recovery_plan/sturgeon_shortnose_1.pdf

	"freshwater amphidromous", i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life (Kieffer and Kynard 1993). Adults in southern rivers forage at the interface of fresh tidal water and saline estuaries and enter the upper reaches of rivers to spawn in early spring (Savannah River: Hall et al. 1991; Altamaha River: Heidt and Gilbert 1979; Flouronoy et al. 1992, Rogers and Weber 1995a; Ogeechee River: Weber 1996).		
Slabside pearlymussel, (<i>Pleuonaia dolabelloides</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
<u>Slender chub</u> (<i>Erimystax cahni</i>)	The slender chub is restricted to the upper Tennessee River drainage in Tennessee and Virginia (US FWS 2014, p. 6)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc4357.pdf
Shiner, smalleye (<i>Notropis buccula</i>)	Occur in fairly shallow, flowing water, often less than 0.5 m deep with sandy substrates (US FWS 2014, p. 45252)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2014-08-04/pdf/2014-17694.pdf
Smalltooth sawfish (<i>Pristis pectinata</i>)	Smalltooth sawfish are tropical marine and estuarine fish that have the northwestern terminus of their Atlantic range in the waters of the eastern United States. In the United States, smalltooth sawfish are generally a shallow water	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS, NOAA. 2001. Federal Register Notice: Proposed Endangered Status for a DPS of Smalltooth Sawfish. http://ecos.fws.gov/docs/federal_register/fr3741.pdf

	fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. (US FWS NMFS, NOAA 2001, p. 19416)		
Sheepnose mussel, (<i>Plethobasus cyphus</i>)	The sheepnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and boulders. Sheepnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)	The shinyrayed pocketbook inhabits small to medium-sized creeks, to rivers in clean or silty sand substrates in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Specimens are often found in the interface of stream channel and sloping bank habitats, where sediment particle size and current strength are transitional. Clench and Turner (1956) noted it preferred small creeks and spring-fed rivers.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Snuffbox Mussel (<i>Epioblasma triquetra</i>)	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Federal Register Notice: Listing. http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27413.pdf#page=2 USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf

<u>Spectaclecase (mussel)</u> <u>(Cumberlandia monodonta)</u>	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
<u>Spotfin chub (Erimonax monachus)</u>	The species is an insectivore, feeding diurnally presumably by both sight and taste in benthic areas of slow to swift current over various substrates with little siltation. Streams may range from 15-60 m in width and, where occupied, 0.3-10.0 m in depth. Water temperature in their summer habitat usually reaches greater than 20°C, and submerged macrophytes are usually absent, occasionally common. The species has been observed associated with sand, gravel, rubble, boulder, and bedrock substrates (Jenkins and Burkhead, 1982) (US FWS 1983, p. 15).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/831121.pdf
Socorro isopod <i>(Thermosphaeroma thermophilus)</i>	Small pools and runs characterized by relatively stable temperatures and physical factors with algae covering most surfaces.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1982. Socorro Isopod Recover Plan. http://ecos.fws.gov/docs/recovery_plan/820216.pdf
Socorro springsnail <i>(Pyrgulopsis neomexicana)</i>	Occurs on stones and among aquatic plants. <i>Pyrgulopsis neomexicana</i> is also found in the uppermost layer of an organic muck substrate with slow moving currents in rivers and streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1991. Final Rule To List the Alamosa Springsnail and the Socorro Springsnail as Endangered http://ecos.fws.gov/docs/federal_register/fr1933.pdf
Sonora chub <i>(Gila ditaenia)</i>	Perennial and spatially intermittent small to moderately sized streams. It prefers pools near cliffs, boulders, or other cover in stream channels. The chub is restricted to one river system.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1992. Sonora Chub Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920930.pdf

	and as noted, is able to move through the system when flows are suitable.		US FWS. Species Fact Sheet for SONORA CHUB (<i>Gila ditaenia</i>) http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Sonora%20Chub%20RB.pdf
Southern kidneyshell (<i>Ptychobranhus jonesi</i>)	It is typically found in medium creeks to small rivers in firm sand substrates with slow to moderate current (Williams et al. 2008, pp. 625).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668
Southern sandshell (<i>Hamiota (=Lampsilis) australis</i>)	The southern sandshell is typically found in small creeks and rivers in stable substrates of sand or mixtures of sand and fine gravel, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61672
Spikedace (<i>Meda fulgida</i>)	Moderate to large perennial streams with moderate to swift currents. It inhabits shallow riffles with sand gravel and rubble substrates. Specific habitat consists of shear zones where rapid flow borders slower flow, areas of sheet flow at the upper end of mid-channel sand/gravel bars and eddies at downstream riffle edges. All suitable habitats are found under 2,000 meters elevation.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E05J.html
Tan riffleshell (<i>Epioblasma florentina</i>)	This species inhabits streams described as shallow and turbid with numerous riffles	The proposed dicamba DGA uses are not expected to overlap	USFWS. 1984. Recovery Plan.

<i>walkeri</i> (=E. <i>walkeri</i>)	and substrate consisting of loose rocks and gravel bars with an abundance of water willow (US FWS, 1984. P, 7).	with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/tan%20riffleshell%20rp.pdf
Tapered pigtoe (<i>Fusconaia burkei</i>)	The tapered pigtoe is found in medium creeks to medium rivers in stable substrates of sand, small gravel, or sandy mud, with slow to moderate current (Williams et al. 2008, p. 296).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61670
Three Forks Springsnail (<i>Pyrgulopsis trivialis</i>)	Shallow waters up to 6 cm (2.35 in) deep, high conductivity, alkaline waters of pH 8, and suitable substrates that are typically firm, characterized by cobble, gravel, sand (and sometimes fine-grained mud), woody debris, and aquatic vegetation such as watercress.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2011. ; Proposed Endangered Status for the Three Forks Springsnail and San Bernardino Springsnail, and Proposed Designation of Critical Habitat; Proposed Rule http://www.gpo.gov/fdsys/pkg/FR-2011-04-12/pdf/2011-8176.pdf
Tubercled blossom (pearly mussel) (<i>Epioblasma torulosa torulosa</i>)	Large-river species that was endemic to the Ohio River system.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2011 Tubercled Blossom <i>Epioblasma torulosa torulosa</i> 5-Year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc3781.%20torulosa.pdf
Virgin River Chub (<i>Gila seminuda</i> (=robusta))	Virgin River chubs are most often associated with deep runs or pool habitats of slow to moderate velocities with large boulders or instream cover, such as root snags. Adults and juveniles are often associated together within these habitats; however, the larger adults are collected most often in the deeper pool habitats within the river.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2013. Virgin River Fishes Recover Plan http://ecos.fws.gov/docs/recovery_plan/950419a.pdf

West Indian Manatee (<i>Trichechus manatus latirostris</i>)	This species lives in freshwater, brackish and marine habitats (US FWS, 2001, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2001. Recovery Plan- Third Revision. http://ecos.fws.gov/docs/recovery_plan/011030.pdf
Woundfin (<i>Plagopterus argentissimus</i>)	Rivers and creeks, depths between 0.15 and 0.42 m and velocities between 0.24 and 0.49 m/s and sandy substrates.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E00Z.html
Yaqui catfish (<i>Ictalurus pricei</i>)	Larger rivers in areas of medium to slow	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1994. Yaqui Fishes Recovery Plan http://ecos.fws.gov/docs/recovery_plan/950329.pdf
Yaqui chub (<i>Gila purpurea</i>)	Inhabits deeper pools of small streams near undercut banks and debris between 1,219 - 1,828 m (4,000 - 6,000 ft). Is also found in pools associated with springheads. Also occurs in artificial ponds.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species Fact Sheet. http://www.fws.gov/southwest/cs/arizona/Documents/Redbook/Yaqui%20Chub%20RB.pdf
Madtom, yellowfin (<i>Noturus flavipinnis</i>)	This species prefers pool habitats beneath cobble and small boulder substrates (Miller 2011). The strongest habitat models identified preferred pools for yellowfin madtoms as greater than 40 meters in length with gravel being the main substrate beneath cover rocks (Miller 2011). (US FWS, 2012, p. 16).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4146.pdf
Zuni Bluehead Sucker (<i>Catostomus discobolus yarrowi</i>)	Stream reaches with clean, perennial water flowing over hard substrate (material on the stream bottom), such as bedrock. Habitat areas are generally shaded with water velocities of less than 0.1 meter per second (0.3 feet per second) in water that was 30 to 50 cm (12 to 20 in) deep with cobble, boulders, and bedrock substrate. Pools often edged by emergent aquatic plants and riparian vegetation.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2014. Endangered Species Status for the Zuni Bluehead Sucker; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2014-07-24/pdf/2014-17205.pdf
American crocodile (<i>Crocodylus acutus</i>)	Found primarily in mangrove swamps and along low-energy mangrove-lined bays, creeks, and inland swamps. During the non-nesting	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.)

	season, they are found primarily in the fresh and brackish-water inland swamps, creeks, and bays, retreating further into the back country in fall and winter. Can be found in inland ponds and creeks, protected coves exposed shorelines mud flats.		http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Atlantic salt marsh snake <i>(Nerodia clarkii taeniata)</i>	The Atlantic salt marsh snake inhabits coastal salt marshes and mangrove swamps. Specifically, it occurs along shallow tidal creeks and pools, in a saline environment ranging from brackish to full strength. It is often associated with fiddler crab burrows.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Profile page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=C01T#lifeHistory
Elkhorn coral <i>(Acropora palmata)</i>	Turbulent shallow water on the seaward face of reefs in water ranging from 1 to 5 m in depth. It has been found in waters up to 30 m in depth.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2008. Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2008-11-26/pdf/E8-27748.pdf#page=1
Okaloosa darter <i>(Etheostoma okaloosae)</i>	Fast-flowing streams. Bottoms are mostly sand, with detritus collecting in areas along the edges and eddy areas where the currents are deflected. Darter streams are heavily shade over most of their courses with ti-ti, alder, wax myrtle, oak, pine, juniper, and black gum.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page http://ecos.fws.gov/docs/life_histories/E00H.html
Squirrel Chimney Cave shrimp <i>(Palaemonetes cumingii)</i>	Squirrel Chimney cave system. Entrance is a steep to vertical sloped sink with a shaft 3-6 ft wide and extends to the main cave and is referred to as a chimney. The cave has bedding plane tunnels, ledges, and a debris cone which opens to an air chamber.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2008. Squirrel Chimney Cave shrimp (<i>Palaemonetes cumingii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1919.pdf
Staghorn coral <i>(Acropora cervicornis)</i>	Staghorn coral commonly grows in more protected, deeper water ranging from 5 to 20 m in depth and has been found in rare instances to 60 m.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2008. Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2008-11-26/pdf/E8-27748.pdf#page=1

Species	Habitat	Rationale	Source
Plants			
Acuna Cactus <i>(Echinomastus erectocentrus var. acunensis)</i>	The acuña cactus occurs in valleys and on small knolls and gravel ridges of up to 30 percent slope in the Palo-Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran desertscrub at 365 to 1,150 m (1,198 to 3,773 ft) in elevation. The plant is not found on all seemingly suitable habitat and microclimate (soil structure, chemistry, and moisture) may be important factors.	The proposed dicamba DGA uses are not expected to overlap with desert environments.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=Q00U#lifeHistory
American chaffseed, <i>(Schwalbea americana)</i>	Habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with pine flatwoods, fire-maintained savannas, wetland or sedge dominated systems.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950929c.pdf
American hart's tongue fern, <i>(Asplenium scolopendrium var. americanum)</i>	Early successional habitats Northern populations occur in forests of secondary growth where canopy openings are abundant. New York populations occur in conifer forests. Bryophyte beds are an important substrate.	The proposed dicamba DGA uses are not expected to overlap early successional forests, conifer forests or bryophyte beds where the species is found.	http://ecos.fws.gov/docs/recovery_plan/930915.pdf
Arizona Cliff-rose <i>(Purshia (=Cowania) subintegra)</i>	Dry. At each site <i>P. subintegra</i> is part of a locally unique vegetative community. The geographic and local distribution of <i>P. subintegra</i> appears to be limited by competition from other plant species rather than a requirement for a specific soil type. Distribution may be limited by competition from creosotebush.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2013. Arizona Cliffrose (<i>Purshia subintegra</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc4260.pdf
Arizona hedgehog cactus	Plants are found on dacite or granite bedrock, open slopes, in narrow cracks between	The proposed uses of dicamba DGA are not	US FWS. 2008. 5-Year Reviews of 28 Southwestern Species

<i>(Echinocereus triglochidiatus var. arizonicus)</i>	boulders, and in the understory of shrubs in the ecotone between Madrean Evergreen Woodland and Interior Chaparral.	expected to overlap with desert habitats.	http://www.gpo.gov/fdsys/pkg/FR-2008-03-20/pdf/E8-5632.pdf#page=1
Brady pincushion cactus <i>(Pediocactus bradyi)</i>	<i>Pediocactus bradyi</i> is restricted to habitat composed of Kaibab limestone chips overlying soil derived from Moenkopi shale and sandstone outcrops. Chert and quartzite pebbles eroded from the Shinarump member of the Chinle Formation are also present at some sites (USFWS 1985). The rock chips that overlay the soil have clear crystalline coatings and a whiter color that appears distinct from the adjacent brown limestones where few or no <i>P. bradyi</i> occur	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2012. Brady Pincushion Cactus (<i>Pediocactus bradyi</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc4036.pdf
Canby's dropwort <i>(Oxypolis canbyi)</i>	Coastal plains - specifically in pond cypress savannas, the shallows and edges of cypress pond/pine sloughs, and wet pine savannas. These are shallowly flooded, open habitats. Found in natural ponds dominated by cypress, grass-sedge dominated Carolina bays. (USFWS 1990) Wetlands (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1990 USFWS Canby's dropwort recovery plan 2010 USFWS Canby's dropwort 5-year review
Canelo Hills ladies'-tresses <i>(Spiranthes delitescens)</i>	Occurs in rare wetland habitats in southern Arizona and northern Sonora, Mexico called "ciénegas." Ciénegas are mid-level wetland communities, often surrounded by relatively arid environments, that are usually associated with perennial springs or stream headwaters. They have permanently or seasonally saturated organic soils, and have a low probability of flooding or scouring.	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1997. ETWP; Determination of Endangered Status for Three Wetland Species Found in Southern Arizona and Northern Sonora, Mexico (62 FR 665 689) http://ecos.fws.gov/docs/federal_register/fr3030.pdf
Carter's small-flowered flax	Proposed PCE's for this species are areas of pine	The proposed uses of dicamba DGA are not	US FWS. 2013. Designation of Critical Habitat for

<i>(Linum carteri carteri)</i>	rockland habitat with frequent disturbances (e.g. fire)	expected to overlap with pine rockland habitats with frequent disturbance regimes.	Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax). http://www.gpo.gov/fdsys/pkg/FR-2013-10-03/pdf/2013-24174.pdf
Clay-loving wild buckwheat <i>(Eriogonum pelinophilum)</i>	Distribution is linked to soil type. Found within swales and drainages. Mat saltbrush community.	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 2009. Clay-loving wild buckwheat 5-year review http://ecos.fws.gov/docs/five_year_review/doc2635.pdf
Cochise pincushion cactus <i>(Coryphantha robbinsorum)</i>	Bedrock and stony soils of the Permian Limestone Formation. Transition zone between the Chihuahuan desert scrub and the semi-desert grassland habitats. Occupies limestone hills. Grows on bedrock areas with very little soil in sunny, open, well-drained areas	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1993. Cochise pincushion cactus (Coryphantha robbinsorum) recovery plan. http://ecos.fws.gov/docs/recovery_plan/930927c.pdf
Butterfly plant, Colorado (<i>Gaura neomexicana</i> var. <i>coloradensis</i>)	This species requires early- to mid-succession riparian habitat. It commonly occurs in habitat types that are usually intermediate in moisture between wet, streamside communities dominated by sedges, rushes, and cattails, and dry, upland short-grass prairie. Typically, Colorado butterfly plant habitat is open, without dense or overgrown vegetation (US FWS, 2010).	The proposed dicamba DGA uses are not expected to overlap with riparian habitat or upland prairies.	USFWS. 2010. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Colorado%20Butterfly%20Plant%20Recovery%20Outline_Final_May%202010.pdf
Colorado hookless Cactus <i>(Sclerocactus glaucus)</i>	Populations of <i>S. glaucus</i> occur on alluvial benches and lower mesa slopes along the Green, Colorado, and Gunnison Rivers. Soils are usually coarse, gravelly river alluvium above the river flood plains. Mancos shale with volcanic cobbles and pebbles form surface material	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 2010. Recovery Outline for the Colorado hookless cactus (<i>Sclerocactus glaucus</i>) http://ecos.fws.gov/docs/recovery_plan/CO%20hookless%20cactus_recovery%20outline_Apr%202010.pdf
Cooley's meadowrue	Grassland/herbaceous, woody wetland, and	The proposed dicamba DGA uses are not expected to	1994 USFWS Recovery Plan

<i>(Thalictrum cooleyi)</i>	herbaceous wetlands (p. i). (USFWS 1994)	overlap with wetlands.	http://ecos.fws.gov/docs/recovery_plan/940421.pdf
DeBeque phacelia <i>(Phacelia submutica)</i>	DeBeque phacelia is restricted to exposures of chocolate to purplish brown and dark charcoal gray alkaline clay soils derived from the Atwell Gulch and Shire members of the Wasatch Formation. These expansive clay soils are found on moderately steep slopes, benches, and ridge tops adjacent to valley floors of the southern Piceance Basin in Mesa and Garfield Counties, Colorado. On these slopes and soils, DeBeque phacelia usually grows only on one unique small spot of ground that shows a slightly different texture, color, and crack pattern than the similar surrounding soils. We do not have a precise scientific description of the soil features required to support this species. The natural shrink-swell cracking process creates the conditions needed for the plants and seed bank to thrive. Its habitat lies at the interface of the North-Central Highlands and Rocky Mountain Section and the Intermountain Semi-desert and Desert Province.	The proposed uses of dicamba DGA are not expected to overlap with steep slopes, benches or ridge tops.	US FWS. 2013. Recovery Outline DeBeque phacelia (<i>Phacelia submutica</i>) http://ecos.fws.gov/docs/recovery_plan/Debeque%20Phacelia%20Recovery%20Outline.pdf
Dudley Bluffs bladderpod <i>(Lesquerella congesta)</i>	Found on drainages along barren outcrops formed by erosion by the downcutting of streams in the Piceance Basin. Grows on level surfaces at the points of ridges and on narrow outcrops of exposed, level, white shale. Surrounding hills and mesas are juniper and pinyon woodlands	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Dudley's bluff bladderpod (<i>Lesquerella congesta</i>) and Dudley's bluff twinpod (<i>Physaria obcordata</i>) recovery plan http://ecos.fws.gov/docs/recovery_plan/930813a.pdf
Dudley Bluffs twinpod <i>(Physaria obcordata)</i>	Found on drainages along barren outcrops formed by erosion by the downcutting of streams in the Piceance Basin. Grows on steep sideslopes. Surrounding hills	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Dudley's bluff bladderpod (<i>Lesquerella congesta</i>) and Dudley's bluff twinpod (<i>Physaria obcordata</i>) recovery plan

	and mesas are juniper and pinyon woodlands.		http://ecos.fws.gov/docs/recovery_plan/930813a.pdf
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)	The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	The proposed dicamba DGA uses are not expected to overlap with grass or sedge-dominated plant communities.	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf
Fickeisen Plains cactus (<i>Pediocactus peeblesianus fickeiseniae</i>)	Occurs on shallow soils derived from exposed layers of Kaibab limestone. Most populations occur on the margins of canyon rims, on flat terraces or benches, or on the toe of well-drained hills with less than 20 percent slope. Within the Plains and Great Basin grasslands and the Great Basin desert scrub vegetation communities.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q1C9#lifeHistory
Florida brickell-bush (<i>Brickellia mosieri</i>)	Proposed PCE's for this species are areas of pine rockland habitat with frequent disturbances (e.g. fire)	The proposed uses of dicamba DGA are not expected to overlap with pine rockland habitats with frequent disturbance regimes.	US FWS. 2013. Designation of Critical Habitat for <i>Brickellia mosieri</i> (Florida Brickell-bush) and <i>Linum carteri</i> var. <i>carteri</i> (Carter's Small-flowered Flax). http://www.gpo.gov/fdsys/pkg/FR-2013-10-03/pdf/2013-24174.pdf

Fringed campion (<i>Silene polypetala</i>)	Occurs in hardwood forests in bottomland and ravines. It is often on fairly steep slopes of deep ravines or north-facing hillsides, sometimes on nearly level ground, particularly in flatwoods developed on Iredell soils. Occurs mainly in small isolated patches of rich hardwood. The great majority of populations occur in the watershed of the Apalachicola River and its tributary, the Flint River. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with forests.	1996 USFWS Technical Agency Draft Recovery Plan for Fringed Campion (<i>Salene polypetula</i>) USFWS Species Profile: Fringed campion (<i>Silene polypetala</i>) (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spscode=Q21P)
Gentian pinkroot (<i>Spigelia gentianoides</i>)	Well drained upland pinelands; longleaf pine-wiregrass ecosystem (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with forests.	2012 US FWS Gentian pinkroot 5-Year Review
Gierisch mallow (<i>Sphaeralcea gierischii</i>)	Found on gypsum outcrops associated with the Harrisburg Member of the Kaibab Formation in northern Mohave County, Arizona and closely adjacent Washington County, Utah. The surrounding plant community is that of warm desertscrub (Mohave desertscrub)	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. Species profile page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spscode=Q3LJ
Gypsum wild-buckwheat (<i>Eriogonum gypsophilum</i>)	Chihuahuan region of the Desert Scrub Formation. The climate is semi-arid and receives an average of about 14 inches of precipitation per year	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1981. 50 CFR Part 17. Endangered and Threatened Plants; Determination of two New Mexico Plants to be Endangered Species and Threatened Species with Critical Habitat. Final Rule. Federal Register / Vol. 46, No. 12 / Monday, January 19, 1981 / Rules and Regulations. http://ecos.fws.gov/docs/federal_register/fr515.pdf
<u>Harperella</u> (<u><i>Ptilimnium nodosum</i></u>)	Harperella is known from only two locations in North Carolina. One population occurs in the Tar River in Granville County. Another population was reintroduced to the Deep	The proposed dicamba DGA uses are not expected to overlap with river habitats.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910305b.pdf

	River recently after the original population known from that area disappeared. This population occurs in Chatham County, but the river serves as the divide between Chatham and Lee counties (US FWS, 1991).		
Holmgren milk-vetch (<i>Astragalus holmgreniorum</i>)	Grows on the shallow, sparsely vegetated soils derived primarily from the Virgin limestone member of the Moenkopi Formation. The species is a principal member of a warm-desert shrub vegetative community.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2006. <i>Astragalus holmgreniorum</i> (Holmgren Milk-Vetch) and <i>Astragalus ampullarioides</i> (Shivwits Milk-Vetch): Recovery Plan http://ecos.fws.gov/docs/recovery_plan/060929.pdf
Holy Ghost ipomopsis (<i>Ipomopsis sancti-spiritus</i>)	Holy Ghost ipomopsis is known from a single population in the Sangre de Cristo Mountains of San Miguel County in north-central New Mexico (Figure 2). Plants are relatively continuous in scattered patches for about 3.5 kilometers (km) (2.2 miles (mi)) of Holy Ghost Canyon beginning 1.6 km (1.0 mi) above the confluence with the Pecos River then up Holy Ghost Creek to the confluence with Doctor Creek. There are about 80 hectares (ha) (200 acres (ac)) of occupied habitat. The Santa Fe National Forest manages most of the habitat. The USFS maintains a campground and leases land in Holy Ghost Canyon as the Holy Ghost Summer Home Area. About 80 percent of the population grows on, or immediately adjacent to, the west-facing cutslopes along Forest Road 122 in Holy Ghost Canyon. Plant density varies from small dense patches (5 plants/m2)	The proposed uses of dicamba DGA are not expected to overlap with montane forest habitats.	US FWS. 2002. Holy Ghost Ipomopsis (<i>Ipomopsis sancti-spiritus</i>) Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020926.pdf

	<p>to single, isolated plants found greater than 50 m from others. The occupied habitat in Holy Ghost Canyon ranges in elevation from 2,350 - 2,500 m (7,730 - 8,220 ft). Holy Ghost ipomopsis occurs in the Rocky Mountain montane conifer forest plant community (Brown 1982). Commonly associated species are ponderosa pine (<i>Pinus ponderosa</i>), Douglas fir (<i>Pseudotsuga menziesii</i>), aspen (<i>Populus tremuloides</i>), Gambel oak (<i>Quercus gambelii</i>), mountain mahogany</p>		
Houghton's goldenrod (<i>Solidago houghtonii</i>)	This plant grows on the shores of the Great Lakes, mainly Lake Huron and Lake Michigan, at the Michigan-Ontario border. (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with shores.	2011 US FWS Houghton's Goldenrod (<i>Solidago houghtonii</i> A. Gray, Asteraceae) 5-Year Review: Summary and Evaluation
Huachuca water-umbel (<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>)	Cienegas (marshy wetlands) and associated vegetation within Sonoran desert scrub, grassland or oak woodland, and conifer forest	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1997. <i>Lilaeopsis schaffneriana</i> ssp. <i>recurva</i> . http://ecos.fws.gov/docs/five_year_review/doc4435.pdf
Jones Cycladenia (<i>Cycladenia humilis</i> var. <i>jonesii</i>)	The species can be found in Eriogonum-Ephedra, mixed desert shrub, and scattered pinyon-juniper communities, at elevations ranging from 4,390 to 6,000 feet elevation in plant communities.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2008. Recover outline for the Jones Cycladenia (<i>Cycladenia humilis</i> var. <i>jonesii</i>) http://ecos.fws.gov/docs/recovery_plan/Jones%20cycladenia_123008.pdf
Kearney's blue-star (<i>Amsonia kearneyana</i>)	South Canyon in the Baboquivari Mountains, Brown Canyon, Jaguar Canyon, and Thomas Canyon. In two distinct habitats: open woodland on unconsolidated slopes of over 20 degrees, and canyon bottoms in full sun to partial shade. once thought to only occupy canyon bottoms, we now know that this is secondary habitat for the species, with most subpopulations being located	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 2013. 5-Year-Review for Kearney Bluestar – 2013 http://ecos.fws.gov/docs/five_year_review/doc4261.pdf

	on steep, dry, and open woodland-dominated slopes		
Knowlton's cactus <i>(Pediocactus knowltonii)</i>	The species occurs on rolling, gravelly hills in a pinon-juniper-sagebrush community at about 1,900 meters (m) (6,200-6,300 feet (ft)).	The proposed uses of dicamba DGA are not expected to overlap with sagebrush habitats.	US FWS. 2010. Knowlton's Cactus (<i>Pediocactus knowltonii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3082.pdf
Kuenzler hedgehog cactus <i>(Echinocereus fendleri var. kuenzleri)</i>	Throughout its range, pinkflower hedgehog cactus occurs in desert grasslands, honey mesquite (<i>Prosopis glandulosa</i>) and other desert shrubland communities, pinyon-juniper (<i>Pinus-Juniperus</i> spp.) woodlands dominated mostly by Colorado pinyon (<i>P. edulis</i>) and oneseed juniper (<i>J. monosperma</i>), and pine-oak (<i>Quercus</i> spp.) woodlands. At the Desert Laboratory in Arizona, pinkflower hedgehog cactus grows in a creosotebush/triangle bursage (<i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i>) community. In a 1941 survey, pinkflower hedgehog cactus was rare in the Colorado River canyon, where it was usually found in association with Engelmann's hedgehog cactus (<i>E. engelmannii</i>).	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1985. Recovery Plan for the Kuenzler's hedgehog cactus http://ecos.fws.gov/docs/recovery_plan/850328a.pdf
Ladies'-tresses, Ute (<i>Spiranthes diluvialis</i>)	Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations are found in riparian woodlands. Observed to be shade-intolerant (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with riverine, spring, or lakeside wet meadows.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950921.pdf USFWS. Species Profile Page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2WA

	Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations also found in riparian woodlands. Observed to be shade-intolerant (US FWS, Species Profile Page).		
Lee pincushion cactus <i>(Coryphantha sneedii var. leei)</i>	Chihuahuan desert scrub to conifer woodlands, rock outcrops (rarely alluvial rubble), usually narrowly confined to cracks in limestone	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1986. Recovery Plan for the Sneed and Lee Pincushion Cacti http://ecos.fws.gov/docs/recovery_plan/860321b.pdf
Leedy's roseroot <i>(Rhodiola integrifolia ssp. leedyi)</i>	New York populations occur on cliffs along the western shore of Seneca lake. In Minnesota, populations occur on moderate cliffs, which are cooled by air exiting underground passages in the karst topography (US FWS, 1998).	The proposed dicamba DGA uses are not expected to overlap with cliffs.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980925.pdf
Lewton's polygala <i>(Polygala lewtonii)</i>	This plant grows on the sandhills of Central Florida and the transition between sandhill and Florida scrub. The land is dominated by longleaf pine, turkey oak, and other oaks. It can also be found in recently cleared areas such as the dry, open clearings around power lines.	The proposed dicamba DGA uses are not expected to overlap with sandhills.	US FWS. 2010. Lewton's polygala (<i>Polygala lewtonii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3261.pdf
Mancos milk-vetch <i>(Astragalus humillimus)</i>	Semi-arid sandstone rimrock ledges and mesa tops. Usually found on large, usually flat sheets of sandstone and is clustered around bowl-like depressions on the bedrock. Also found in cracks and fissures in the	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1989. Mancos milkvetch recovery plan http://ecos.fws.gov/docs/recovery_plan/891220.pdf

	sandstone and at the base of slickrock inclines.		
Mesa Verde cactus <i>(Sclerocactus mesae-verdae)</i>	In general, the cactus is restricted to the Mancos and Fruitland Shale Formations which have high alkalinity are gypsiferous and shrink-swell properties that make them harsh sites for plant life. The Mesa Verde cactus is most frequently found growing on the tops of hills or benches, slopes of hills and very rarely on level ground between the hills or benches.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1984. Mesa Verde Cactus Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840330a.pdf
Miccosukee gooseberry (<i>Ribes echinellum</i>)	Mixed mesophytic hardwoods (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with forests.	2008 US FWS Miccosukee Gooseberry 5-Year Review
Michaux's sumac (<i>Rhus michauxii</i>)	It is endemic to the inner coastal plain and piedmont of the Carolinas, Georgia, and Florida, where it occupies sandy or rocky open woods. It appears to depend upon some form of disturbance to maintain the open quality of its habitat. (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with sandy or rocky open woods.	1993 USFWS RECOVERY PLAN for Michaux's Sumac (<i>Rhus michauxii</i>) Sargent
Navajo sedge <i>(Carex specuicola)</i>	Endemic to Navajo nation, and is now restricted to Navajo Sandstone Formation bedrock seep-spring pockets or in hanging gardens within the Great Basin conifer woodland at an elevation of 1740m to 1824 m. May have occurred in lower riparian areas in other canyons on the Navajo Nation. Grows in variety of situations, from inaccessible sheer cliff faces to accessible alcoves. Dominant associated species include monkey flower (<i>Mimulus eastwoodiae</i>), helleborine (<i>Epipactis gigantea</i>), water bentgrass (<i>Agrostis semiverticillata</i>), sand bluestem (<i>Andropogon hallii</i>), thistle (<i>Cirsium</i> spp.) Foxtail barley (<i>Hordeum</i>	The proposed uses of dicamba DGA are not expected to overlap with hanging garden habitats.	US FWS. 1987. Navajo Sedge (<i>Carex specuicola</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/870924.pdf

	jubatum), and common reed (<i>Phragmites communis</i>).		
Nichol's Turk's head cactus (<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>)	The cactus grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or shouldered next to rocks on steep slopes and within limestone outcrops.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2009. Nichol's Turk's Head Cactus (<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2509.pdf
North Park phacelia (<i>Phacelia formosula</i>)	Outcrops are rust-yellow sandstone and sandy areas along steep slopes, dissected by ravines, sparsely vegetated. More individuals are found on steep sided ravines. Other plants found in association include the genera <i>Mentzelia</i> , <i>Chrysothamnus</i> , <i>Oryzopsis</i> , <i>Arenaria</i> , <i>Eriogonum</i> , and <i>Rosa</i>	The proposed uses of dicamba DGA are not expected to overlap with steep slopes.	US FWS. 1986. North Park Phacelia (<i>Phacelia formosula</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/860321.pdf
Northeastern bulrush (<i>Scirpus ancistrochaetus</i>)	Found in ponds, wet depressions, or shallow sinkholes within small (generally less than one acre) wetland complexes. These wetlands are characterized by seasonally variable water levels (p. i) In general, the northeastern bulrush tends to grow in acidic to circumneutral natural ponds, shall sinkholes, wet depressions (wet meadows and marshes) found in hilly country (p. 28). Wetlands occupied by the species in the northern part of its range do not appear to have any obvious unique habitat characteristics; indeed, many wetlands appear to have habitat suitable for the plant but do not harbor it (p. 28). Common to all of the ponds occupied by <i>S. ancistrochaetus</i> , however, are water levels that fluctuate seasonally and/or annually,	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Recovery Plan http://ecos.fws.gov/docs/recovery_plan/930825.pdf

	from inundation (in late winter and spring) to saturation (in summer and late fall) (p. 28).		
Northern wild monkshood (<i>Aconitum noveboracense</i>)	Typical habitat is shaded to partially shaded cliffs and talus slopes or in New York, also occurs in semi-shaded seepage springs at high elevation headwaters. Various bedrock types from sandstones to dolomite and others act as substrates. All habitats have a cold soil environment associated with active and continuous cold air drainage or cold ground water flowage out of the nearby bedrock. Typically cliff and talus slope populations are associated with openings or caves, often ice-filled, through which the cold air emanates (US FWS, 1983, p. 18-20).	The proposed dicamba DGA uses are not expected to overlap with cliffsides, rockfalls at cliff bases or springs associated with cold air or water.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/830923.pdf
Osterhout milkvetch (<i>Astragalus osterhoutii</i>)	Middle Park desert badlands surrounded by high ranges of the Rocky Mountains and characterized by open grassy vegetation with scattered shrubs of big sagebrush, rabbitbrushes, bitterbrush, horsebrush, winterfat, snowberry, and/or mountain mahogany. Osterhout milkvetch shows evidence of light grazing and can be found on old road cuts and fills, Occur within six (6) miles to the north and east of the town of Kremmling.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1992. 1992_USFWS_Osterhout milkvetch (<i>Astragalus osterhoutii</i>) and penland beardtongue (<i>Penstemon penlandii</i>) recovery plan http://ecos.fws.gov/docs/recovery_plan/920930c.pdf

Pagosa skyrocket <i>(Ipomopsis polyantha)</i>	Shale outcrops— The Pagosa Skyrocket is limited to the Mancos Shale	The proposed uses of dicamba DGA are not expected to overlap with shale outcrops.	US FWS. . ECOS: Pagosa skyrocket (<i>Ipomopsis polyantha</i>) Species Profile - Life History http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2U7#lifeHistory
Parachute beardtongue <i>(Penstemon debilis)</i>	Steep, continually shifting surface layers of broken shale rubble, along with sparse (less than 10 percent cover) vegetation of other oil shale-specific plants on the Parachute Creek Member and Lower Part of the Green River geologic formations. Rocky Mountain Cliff and Canyon plant community.	The proposed uses of dicamba DGA are not expected to overlap with shale outcrops.	US FWS. 2013. Recovery Outline Parachute beardtongue (<i>Penstemon debilis</i>) http://ecos.fws.gov/docs/recovery_plan/Parachute%20Beardtongue%20Recovery%20Outline.pdf
Pecos (=puzzle, =paradox) sunflower <i>(Helianthus paradoxus)</i>	Pecos sunflower is a wetland plant that grows on wet, alkaline soils at spring seeps, wet meadows, stream courses and pond margins. It has seven widely spaced populations in west-central and eastern New Mexico and adjacent Trans-Pecos Texas. These populations are all dependent upon wetlands from natural groundwater deposits. Incompatible land uses, habitat degradation and loss, and groundwater withdrawals are historic and current threats to the survival of Pecos sunflower. (USFWS 2005)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2005 Final Pecos Sunflower Recovery Plan Available at: http://www.fws.gov/southwest/es/documents/r2es/pecos_sunflower_final_recovery_plan.pdf
Peebles Navajo cactus <i>(Pediocactus peeblesianus var. peeblesianus)</i>	The species occurs in desert habitat and the transition to Great Basin grassland habitat.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2008. Peebles Navajo Cactus(<i>Pediocactus peeblesianus</i> var. <i>peeblesianus</i>) 5-Year Review: Summary and Evaluation

			http://ecos.fws.gov/docs/five_year_review/doc1960.pdf
Penland alpine fen mustard <i>(Eutrema penlandii)</i>	small calcareous wetlands, Oligotrophic rheotrophic alpine marshes	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Eutrema penlandii (Penland alpine mustard) Federal Register document http://ecos.fws.gov/docs/recovery_plan/920930c.pdf
Penland beardtongue <i>(Penstemon penlandii)</i>	Penstemon penlandii is found in co-existence with Astragalus osterhoutii and both are endemic to Middle Park, a high elevation sagebrush park at 7,500 feet, surrounded by various ranges of the Rocky Mountains, in Grand County, Colorado. It is found in badlands of Pierre Shales and of late Tertiary (Miocene Troublesome Formation) in siltstone sediments and the habitat is characterized by an open grassy vegetation with scattered shrubs of big sagebrush, rabbitbrushes, bitterbrush, horsebrush, winterfat, snowberry, and/or mountain mahogany	The proposed uses of dicamba DGA are not expected to overlap with sagebrush habitats.	US FWS. 1992. OSTERHOUT KILKVETCH (Astragalus osterhoutii) PENLAND BEARDTONGUE (Penstemon penlandii) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/920930c.pdf
Peter's Mountain mallow <i>(Iliamna corei)</i>	Iliamna corei occurs in the shallow soil of the Clinch sandstone outcrops on the northwest-facing slope of Peters Mountain	The proposed uses of dicamba DGA are not expected to overlap with sandstone outcrops.	US FWS. 1990. Peters Mountain Mallow (Iliamna corei) (Sherli) Sherff) RECOVERY PLAN http://ecos.fws.gov/docs/recovery_plan/900928a.pdf
Pima pineapple cactus <i>(Coryphantha scheeri var. robustispina)</i>	Desert scrubland or the ecotone between desert scrubland and desert grasslands on flat terrain.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2007. Pima Pineapple Cactus 5-Year Review Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1041.pdf
Roan Mountain bluet, (Hedyotis purpurea var. montana)	This species grows in shallow soils and crevices of cliffs and outcrops and on thin rocky soils of grassy balds (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with cliffs and outcrops.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960513.pdf
Rock gnome lichen <i>(Gymnoderma lineare)</i>	Rock gnome lichen is primarily limited to vertical rock faces where seepage water from forest	The proposed dicamba DGA uses are not expected to overlap with high	http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html

	<p>soils above flows during (and only during) very wet times. It appears the species needs a moderate amount of light, but that it cannot tolerate high-intensity solar radiation. It does well on moist, generally open, sites, with northern exposures, but needs at least partial canopy coverage where the aspect is southern or western</p> <p>Rock gnome lichen is known from the Southern Appalachian Mountains of North Carolina and South Carolina, Tennessee, and Georgia, in areas of high humidity, either at high elevations, where it is frequently bathed in fog, or in deep gorges at lower elevations.</p>	elevation vertical rock faces where the species occurs.	
Running buffalo clover (<i>Trifolium stoloniferum</i>)	<p>Running buffalo clover occurs in mesic habitats of partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or</p>	The proposed dicamba DGA uses are not expected to overlap with mesic habitats where the clover is expected to be found.	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

	savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).		
Sacramento Mountains thistle (<i>Cirsium vinaceum</i>)	Occur in wetlands, or subirrigated areas associated with springs, streams, and seeps. Most existing populations are in mixed conifer/mountain meadow settings. Riparian habitat on wet travertine deposits. It typically has meadows and streams on steep slopes with little other vegetation, including grass	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Sacramento mountains thistle (<i>Cirsium vinaceum</i>) recovery plan. http://ecos.fws.gov/docs/recovery_plan/930927a.pdf
Sacramento prickly poppy (<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>)	Occurs in steep, rocky canyons between the pinyon/juniper zone of the Chihuahuan Desert Scrublands and Grasslands (1,310 m [4,300 ft]), and the lower edge of the ponderosa pine community of the Great Basin Conifer Woodlands (2,164 m [7,100 ft]). Habitats include arid canyon bottoms, dry terraces above riparian areas, and stream banks, as well as areas around springs and seeps. Plants grow directly in the rocks and gravel of stream beds; on vegetated bars of silt, gravel, and rock; on cut slopes; and on terraces above stream channels.	The proposed uses of dicamba DGA are not expected to overlap with canyon habitats.	US FWS. 2013. Sacramento prickly poppy 5-year review http://ecos.fws.gov/docs/five_year_review/doc4324.pdf
San Francisco Peaks ragwort (<i>Packera franciscana</i>)	Found on the talus slopes in the alpine fellfield on the San Francisco Peaks. 3,445-3,780 m. Ground surface is gravelly and existing boulders are more rounded with better lichen development than in the boulder field. Plant common in fine-medium grain soils on inclines from moderate to 60%; aspect ranged from 45-315 degrees, with largest population/greatest densities on slopes with aspects from	The proposed uses of dicamba DGA are not expected to overlap with alpine habitats.	US FWS. 1987. Recovery Plan for San Francisco Peaks Groundsel <i>Senecio franciscanus</i> Greene http://ecos.fws.gov/docs/recovery_plan/870721.pdf

	180-270 degrees. Vegetation here is of low stature, sparse, characterized by herbs, grasses, occasional shrubs, and at timberline by dwarf trees.		
Sandplain gerardii (<i>Agalinis acuta</i>)	Typically occurs on dry, sandy, poor-nutrient soils of sparsely vegetated sandplain environments and serpentine barrens. Lives in grassland communities.	The proposed uses of dicamba DGA are not expected to overlap with grassland habitats.	US FWS. 1989. Sandplain gerardia recovery plan http://ecos.fws.gov/docs/recovery_plan/890920.pdf
Scrub mint (<i>Dicerandra frutescens</i>)	<i>Dicerandra frutescens</i> is mostly restricted to excessively drained, yellow sandy soils of the Astatula and Paola soil types. However, it has been found on a moderately well-drained, yellow sand of the Orsino type. The plant requires periodic fire to maintain populations and populations decline in areas without fire in as little as five years. Row crop lands are expected to be maintained in a fireless state continually and it is not reasonable to assume that population of this species persist in row cropped areas.	The proposed 2,4-D choline use sites are not expected to provide appropriate fire influenced habitat.	US FWS. 2009. Scrub Mint (<i>Dicerandra frutescens</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2492.pdf
Seabeach amaranth (<i>Amaranthus pumilus</i>)	Barrier island beaches of the Atlantic coast, inlets, temporary habitats, may move as areas become suitable or unsuitable habitat. Overwash flats at accreting ends of islands, lower foredunes and upper strands of noneroding beaches (landward of the wrackline). Does not occur on well-vegetated sites. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with beaches.	1996 Weakley, Bucher, Murdock U.S. Fish and Wildlife Service. 1996. Recovery Plan for Seabeach Amaranth. (<i>Amaranthus pumilus</i>) Rafinesque). Atlanta, Georgia. http://ecos.fws.gov/docs/recovery_plan/961112b.pdf . 2007 USFWS Seabeach Amaranth Five-Year Review; http://ecos.fws.gov/docs/five_year_review/doc1068.pdf
Sensitive joint-vetch (<i>Aeschynomene virginica</i>)	Occurs in fresh to slightly brackish tidal river systems, within the intertidal zone where populations are flooded	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1995 USFWS Sensitive joint-vetch recovery plan 2012 USFWS Sensitive joint-vetch 5-year review

	<p>twice daily. Typically occur in the estuarine meander zone of tidal rivers where sediments transported from upriver settle out and extensive marshes form. Need disturbed/open habitats such as: accreting point bars that have not yet been colonized by perennial species, low swales within extensive marshes, areas of nutrient deficiencies in saturated organic sediments, or areas of muskrat herbivory. (USFWS 1995)</p> <p>Majority are found in natural tidal marsh habitats, but also a few documented cases of a pocket marsh wetland, edge of a moist soybean field, and a mowed grassy strip between a manmade drainage channel and dirt road. (USFWS 2012)</p>		
<p>Sentry milk-vetch (<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>)</p>	<p>Found on scarcely visible cracks in Kaibab limestone, in sand-filled hollows in rock, or on shallow gravelly soils.</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with limestone outcrops.</p>	<p>US FWS. 2009. Sentry milk-vetch 5-Year Review</p> <p>http://ecos.fws.gov/docs/action_plans/doc3054.pdf</p>
<p>Shale barren rock cress (<i>Arabis serotina</i>)</p>	<p>This plant grows on the soils of the restricted to shale barrens and adjacent woodlands found in western Virginia and eastern West Virginia.</p> <p>Shale barren is a designation for a shale slope of the region with an open, scrubby growth of pine, oak, red cedar, and other woody species adapted to the xeric conditions. Amidst the woody growth, which may form a canopy cover of less than 10%, an open herbaceous cover is found with species</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with shale barren or woodland habitats.</p>	<p>US FWS. 1991. SHALE BARREN ROCK (<i>Arabis serotina</i>) Recovery Plan</p> <p>http://ecos.fws.gov/docs/recovery_plan/910815.pdf</p>

	also adapted to the harsh conditions.		
Siler pincushion cactus (<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>)	Badland like rolling hills.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1986. Recovery Plan for the <i>Pediocactus sileri</i> http://ecos.fws.gov/docs/recovery_plan/860414b.pdf
Small-anthered bittercress (<i>Cardamine micranthera</i>)	Native to small streambank seeps, adjacent sandbars, and stream edges in the Dan River drainage of the North Carolina and Virginia piedmont. (USFWS 1991) This plant occurs in moist and wet, shady areas near streams and in dim woodlands. Small-anthered bittercress is known only from the Dan River basin in north-central North Carolina (Stokes County) and south-central Virginia (Patrick County). (USFWS 1998)	The proposed dicamba DGA uses are not expected to overlap with stream edges.	1991 USFWS Recovery Plan for the Small-anthered bittercress <i>Cardamine micranthera</i> 1998 USFWS Recovery Plan for the <i>Cardamine micranthera</i>
Small whorled pogonia (<i>Isotria medeoloides</i>)	The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil	The proposed dicamba DGA uses are not expected to overlap with mixed deciduous/coniferous forests.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf

	moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).		
Smooth coneflower (<i>Echinacea laevigata</i>)	The habitat of smooth coneflower consists of open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium- and calcium-rich soils associated with amphibolite, dolomite, or limestone (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with open woods, barrens, or bluffs.	2011 USFWS Smooth Coneflower (<i>Echinacea laevigata</i>) 5-Year Review: Summary and Evaluation
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)	The Sneed and Lee pincushion cacti grow in semi-desert grassland (Brown, 1982). The Sneed pincushion cactus is restricted to limestone and grows in cracks on vertical cliffs or ledges. The Sneed pincushion cactus grows at an elevation of 1,200-2,350 m in areas where the average precipitation varies from 19.7 to 40 cm per year. Edaphic requirements are poorly understood. (USFWS 1986)	The proposed dicamba DGA uses are not expected to overlap with semi-desert grasslands.	1986 USFWS Recovery Plan for the Sneed and Lee Pincushion Cacti. Pages 8-9. Available at: http://ecos.fws.gov/docs/recovery_plan/860321b.pdf
Swamp pink (<i>Helonias bullata</i>)	Swamp pink is found in a variety of wetland habitats, including swampy forested wetlands bordering small streams; headwater wetlands; sphagnous, hummocky, dense Atlantic white cedar swamps; Blue Ridge swamps; meadows; bogs;	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1991 USFWS Swamp Pink (<i>Helonias bullata</i>) Recovery Plan Available at: http://ecos.fws.gov/docs/recovery_plan/910930c.pdf

	and spring seepage areas (USFWS 1991)		
Todsen's pennyroyal (<i>Hedeoma todsenii</i>)	<p>Todsen's pennyroyal occurs in the Great Basin Conifer Woodland community where piñon pine (<i>Pinus edulis</i>) and one seed juniper (<i>Juniperus monosperma</i>) are the dominant species (Brown and Lowe 1980). Besides piñon and juniper, other common associates with Todsen's pennyroyal include mountain mahogany (<i>Cercocarpus montanus</i>), yellowleaf silktassel (<i>Garrya flavescens</i>), wavyleaf oak (<i>Quercus undulata</i>), white ragweed (<i>Hymenopappus radiatus</i>), snakeweed (<i>Gutierrezia</i> sp.), and muhly grass (<i>Muhlenbergia</i> sp.). Todsen's pennyroyal does not appear to associate consistently with any particular species. It grows (and flowers) in the shade of piñon pines and junipers, and in woodland openings with thin grasses (mostly <i>Muhlenbergia</i> sp.). At some sites, it is absent from thickets of wavyleaf oak; at other sites, flowering plants are under wavyleaf oak and other shrubs (The Nature Conservancy, New Mexico Field Office 1990; Sarah Wood, pers. comm. 1993). Todsen's pennyroyal is restricted to loose, gypseous-Plants grow in loose limestone substrates associated with or positioned gypseous-limestone immediately below the Permian Yeso Formation soils on north-facing (NMFRCD 1991) Most plants are on steep (20-70 slopes degree), north-facing slopes, with a surface of scree or</p>	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	<p>US FWS. 2001. Todsen's Pennyroyal Recovery Plan - 2001</p> <p>http://ecos.fws.gov/docs/recovery_plan/010131.pdf</p>

	gravelly cobble; however, some plants at Mountain Lion Peak are on small, nearly level terraces along intermittent streams. The substrates have a thin layer of conifer litter over a mixture of limestone and finer materials.		
Virginia round-leaf birch <i>(Betula uber)</i>	Transitional between the oak-pine and maple-beech-birch associations, with some tendencies toward the elm-ash-cottonwood association because of the riparian setting. Disturbance and moderate levels of incoming solar radiation associated with seedling establishment	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 1990. 1990_USFWS_Virginia round-leaf birch (<i>Betula uber</i>) recovery plan http://ecos.fws.gov/docs/recovery_plan/900924a.pdf
Virginia sneezeweed <i>(Helenium virginicum)</i>	Seasonal wetlands, sink hole ponds varying from forest settings to farm pond margins.	The proposed dicamba DGA uses are not expected to overlap sink hole ponds and seasonal wetlands.	http://ecos.fws.gov/docs/recovery_plan/001002.pdf
Spiraea, Virginia <i>(Spiraea virginiana)</i>	<i>Spiraea virginiana</i> is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-18.).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf
Welsh's milkweed <i>(Asclepias welshii)</i>	Aeolian sand dunes in a plant community dominated by sand mulesears with prominent groves of ponderosa pine and clumps of Gambel oak. Vegetation surrounding the sand dune habitat is dominated by	The proposed uses of dicamba DGA are not expected to overlap with woodland or sagebrush habitats.	US FWS. 1992. Welsh's Milkweed (<i>Asclepias welshii</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/920930a.pdf

	pinon-juniper woodlands with sagebrush.		
Zuni fleabane <i>(Erigeron rhizomatus)</i>	Found on red detrital clay with steep easily erodable slopes that do not crust over. Associated with pinon-juniper woodland. Prefers slopes of up to 40 degrees, usually with a north-facing aspect, but it also occurs on eastern and western exposures. It never occurs on slopes with a southern aspect.	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 1988. Zuni fleabane recovery plan http://ecos.fws.gov/docs/recovery_plan/880930.pdf
Aboriginal Prickly-apple <i>(Harrisia aboriginum)</i>	This cactus occurs in Florida in coastal strand vegetation (relatively low salt-tolerant shrubs and grasses), tropical coastal hammocks with trees including gumbo limbo (<i>Bursera simaruba</i>), wild lime (<i>Zanthoxylum fagara</i>), or live oak (<i>Quercus virginiana</i>). Populations are likely to be on shell mounds created by pre-European local residents, or at least on sites with shelly substrates. Plants may be quite close to the mangrove zone	The proposed uses of dicamba DGA are not expected to overlap with habitats on shelly substrates or vegetation that is at all salt-tolerant.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q0DR
Apalachicola rosemary <i>(Conradina glabra)</i>	Xeric longleaf pine communities; prefers sunny or lightly shaded areas. Edges of steephead ravines, upland pine-wiregrass vegetation, also found in right-of-ways, edges of roads in pine plantations	The proposed uses of dicamba DGA are not expected to overlap with woody habitats.	US FWS. 2009. <i>Conradina glabra</i> (Apalachicola rosemary) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2421.pdf
Avon Park harebells <i>(Crotalaria avonensis)</i>	Sparsely vegetated, xeric white sand scrub. Prefers (but does not require) open scrub, with less vegetation cover and more bare sand.	The proposed uses of dicamba DGA are not expected to overlap with scrubland habitats or areas of bare sand.	Avon Park harebells (<i>Crotalaria avonensis</i>) 5-Year Review: Summary and Evaluation US FWS. 2007. http://ecos.fws.gov/docs/five_year_review/doc1067.pdf
Beach jacquemontii <i>(Jacquemontia reclinata)</i>	<i>Jacquemontia reclinata</i> requires open areas that are typically found on the crest and lee sides of stable dunes (Austin 1979), and may also invade and restabilize maritime hammock or coastal strand communities that have been disturbed by tropical storms, hurricanes, and	The proposed uses of dicamba DGA are not expected to overlap with sand dune or maritime habitats.	US FWS. 1999. South Florida Field Office Multi-Species Recovery Plan http://ecos.fws.gov/docs/recovery_plan/140903.pdf

	possibly fire. Common vegetative associates found with <i>J. reclinata</i> include sea grape (<i>Coccoloba uvifera</i>), cabbage palm (<i>Sabal palmetto</i>), poisonwood (<i>Metopium toxiferum</i>), Madagascar periwinkle (<i>Catharanthus roseus</i>), Croton involucrata, gopher apple (<i>Licania michauxii</i>), prickly pear cactus (<i>Opuntia</i> sp.), sandspurs (<i>Cenchrus</i> spp.), sea oats (<i>Uniola paniculata</i>) and other shrubs and dwarfed trees. It is also an inhabitant of disturbed or sunny areas In the tropical maritime hammock (hardwood forest) or the coastal strand vegetation, typically with sea grape (<i>Coccoloba uvifera</i>) and other shrubs and dwarfed trees. It usually occurs with more or less weedy plants such as Madagascar periwinkle (<i>Catharanthus roseus</i>) and sand spurs (<i>Cenchrus</i> spp.). It occasionally occurs in the beach dune community with sea oats (<i>Uniola paniculata</i>).		
Beautiful pawpaw (<i>Deeringothamnus pulchellus</i>)	Pristine and modified pine flatwoods, roadsides, and mowed areas	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats or roadsides and mowed areas.	US FWS. 2009. Beautiful pawpaw (<i>Deeringothamnus pulchellus</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2588.pdf
Britton's beargrass (<i>Nolina brittoniana</i>)	Occurs in scrub, high pineland, and even occasionally in hammocks.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or woodland habitats.	US FWS. 1996. Recovery Plan for Nineteen Central Florida Scrub and High Pineland Plants (revised) (960622) http://ecos.fws.gov/docs/recovery_plan/960622.pdf
Brooksville bellflower (<i>Campanula robinsiae</i>)	Deciduous forest: Occurs on pond margins, wet prairies, and seepage areas in adjacent hardwood forests, Also along the margins of marshes. Important characteristic is	The proposed uses of dicamba DGA are not expected to overlap with forested or wetland habitats	US FWS. 1994. Recovery plan Brooksville bellflower (<i>Campanula robinsiae</i>) and Cooley's water willow (<i>Justicia cooley</i>).

	that the water line fluctuates. Often the Brooksville bellflower's habitat is surrounded by pastures		http://ecos.fws.gov/docs/recovery_plan/940620b.pdf
Cape Sable Thoroughwort (<i>Chromolaena frustrata</i>)	Grows in open canopy habitats in coastal berms and coastal rock barrens, and in semi-open to closed canopy habitats, including buttonwood forests, coastal hardwood hammocks, and rockland hammocks. <i>C. frustrata</i> is often found in the shade of associated canopy and subcanopy plant species	The proposed uses of dicamba DGA are not expected to overlap with coastal or woodland habitats	US FWS. 2014. Designation of Critical Habitat for <i>Chromolaena frustrata</i> (Cape Sable Thoroughwort); Final Rule http://www.gpo.gov/fdsys/pkg/FR-2014-01-08/pdf/2013-31576.pdf
Carter's mustard (<i>Warea carteri</i>)	Found almost exclusively in upland areas. It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. Near the south end of its range (e.g., ABS), Carter's mustard is found primarily in scrubby flatwoods. Also grows along sandy trails and roadsides.	The proposed uses of dicamba DGA are not expected to overlap with sandhills or flatwoods habitats.	US FWS 2008. Carter's mustard (<i>Warea carteri</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1977.pdf
Chapman rhododendron (<i>Rhododendron chapmanii</i>)	Transitional area between upland mesic or scrubby flatwoods and floodplain swamps or baygalls. Also found in mesic pine flatwoods or on the lower elevations of sandhills. Fire dependent community. Camp Blanding population grows on the edge of a xeric hammock next to a stream bank. The Camp Blanding sites are dominated by sand live oak (<i>Quercus germinata</i>), laural oak (<i>Q. hemisphaerica</i>), and water oak (<i>Q. nigra</i>). Gulf and Liberty/Gadsden populations are dominated by wiregrass, longleaf pine and/or slash pine.	The proposed uses of dicamba DGA are not expected to overlap with wetland or woodland habitats and are not expected to be associated with frequent fires.	US FWS. 2010. Chapman's Rhododendron (<i>Rhododendron minus</i> var. <i>chapmanii</i>) 5 year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc3201.pdf

Cooley's water-willow <i>(Justicia cooleyi)</i>	Hardwood forests and hardwood pine forests. Also found along roadways among species of various grasses and herbs.	The proposed uses of dicamba DGA are not expected to overlap with forested habitats or along roadways.	US FWS. 1994. Brooksville bellflower and Cooley's water-will recovery plan. http://ecos.fws.gov/docs/recovery_plan/940620b.pdf
Crenulate lead-plant <i>(Amorpha crenulata)</i>	Historically, this species occupied the ecotone between wet prairie and pine rockland, but wet prairie habitat no longer exists in the sites containing the two largest natural populations, and pine rockland is rare. Prefers open sun to partial shade sites.	The proposed uses of dicamba DGA are not expected to overlap with wetland, forested or rockland habitats.	US FWS. 2007. Crenulate lead-plant (<i>Amorpha crenulata</i>) 5-Year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc1111.pdf
Deltoid spurge <i>(Chamaesyce deltoidea ssp. deltoidea)</i>	Pine rocklands of Miami Rock Ridge. Open shrub canopy, exposed limestone, and minimal litter	The proposed uses of dicamba DGA are not expected to overlap with wooded habitats and exposed soils.	US FWS. 2010. Deltoid Spurge (<i>Chamaesyce deltoidea ssp. deltoidea</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3243.pdf
Etonia rosemary <i>(Conradina etonia)</i>	Deep white sand scrub with shrubby evergreen oaks and sand pines; occur in natural openings/disturbed areas	The proposed uses of dicamba DGA are not expected to overlap with scrubland wooded habitats	US FWS. 1994. Etonia rosemary recovery plan http://ecos.fws.gov/docs/recovery_plan/940927c.pdf
Florida bonamia <i>(Bonamia grandiflora)</i>	Occurs mainly in scrub, but occasionally occurs in high pinelands in the Ocala National Forest (pg 14); In Ocala National Forest, the bonamia has been observed in the following stand condition classes of sand pine: regeneration, seedling and sapling, immature poletimber, mature poletimber (pg 15).	The proposed uses of dicamba DGA are not expected to overlap with scrubland or wooded habitats.	US FWS. 1996. Recovery Plan for Nineteen Central Florida Scrub and High Pineland Plants (revised) (960622) http://ecos.fws.gov/docs/recovery_plan/960622.pdf
Florida golden aster <i>(Chrysopsis floridana)</i>	Prefers open, sandy areas within the sand pine scrub community. They have been found growing in the ecotone between scrub and other communities. Historically, <i>C. floridana</i> was known to occur in scrub habitat on coastal dunes, and was reintroduced to this habitat type at Fort Desoto County Park.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or wooded habitats.	US FWS. 2009. Florida Golden-aster 5-year review http://ecos.fws.gov/docs/five_year_review/doc2411.pdf

Florida perforate cladonia (<i>Cladonia perforata</i>)	This lichen occurs on a barrier island in the Florida panhandle (Okaloosa County) and in scrub vegetation	The proposed uses of dicamba DGA are not expected to overlap with barrier island or scrubland habitats.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.) http://ecos.fws.gov/docs/recovery_plan/140903.pdf
Florida Semaphore Cactus (<i>Consolea corallicola</i>)	Occurs on rockland hammocks; coastal berm, and buttonwood forests. <i>Consolea corallicola</i> also occurs on sandy soils and limestone rockland soils with little organic matter and seems to prefer areas where canopy cover and sun exposure are moderate.	The proposed uses of dicamba DGA are not expected to overlap with rocky, coastal or wooded habitats.	US FWS. 2013. Determination of Endangered Status for <i>Chromolaena frustrata</i> (Cape Sable Thoroughwort), <i>Consolea corallicola</i> (Florida Semaphore Cactus), and <i>Harrisia aboriginum</i> (Aboriginal Prickly-Apple); Final Rule http://www.gpo.gov/fdsys/pkg/FR-2013-10-24/pdf/2013-24177.pdf
Florida skullcap (<i>Scutellaria floridana</i>)	The primary habitat of Florida skullcap is wet longleaf pine flatwoods and wet prairie, within the grassy seepage bog communities at the edge of forested or shrubby wetlands, a habitat defined as a fire-dependent community. It is also found in the ecotones between mesic flatwoods and swamps sites or grassy margins of wetland habitats, and somewhat disturbed wetland savanna. Florida skullcap can be found growing in full sun or light shade.	The proposed uses of dicamba DGA are not expected to overlap with wetland or forested habitats or in areas with frequent fire disturbance.	US FWS. 2009. <i>Scutellaria floridana</i> (<i>Florida skullcap</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2416.pdf
Florida torreya (<i>Torreya taxifolia</i>)	The Florida torreya is a dioecious coniferous tree found in the slope forest (FNAI 2010) that cover hammocks, steep, deeply shaded limestone slopes and wooded ravines along the east side of the Apalachicola River in Florida (Fig. 1), and adjacent Lake Seminole in Georgia. Soils in these areas are within the orders Alfisols and Mollisols. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with forests.	USFWS 2010. <i>Torreya taxifolia</i> (<i>Florida torreya</i>) 5-Year Review. Page 13. Available at: http://ecos.fws.gov/docs/five_year_review/doc3258.pdf
Florida ziziphus	Seems to prefer high pine habitats or the transition zone	The proposed uses of dicamba DGA are not	US FWS. 2009. Florida Ziziphus

<i>(Ziziphus celata)</i>	between scrubby flatwoods and high pine. In general habitat characterization for this particular species is extremely complexed. Many of the known sites are in pasture and one site in particular is identified as a Remnant Sandhill. Another site in particular is described as open Oak Hickory, yellow sand scrub.	expected to overlap with wooded habitats.	<i>(Ziziphus celata)</i> 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2587.pdf
Four-petal pawpaw <i>(Asimina tetramera)</i>	Found on sand pine scrub vegetation on old, coastal dunes 1979). The species grows in excessively-drained, quartz sand of both the Paola and the St. Lucie soil series showing a preference for the Paola soils. <i>Asimina tetramera</i> is found in various seral stages of sand pine scrub, ranging from open [no canopy] to mature [closed canopy] and is adapted to infrequent, intense fires, perhaps every 20 to 80 years.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or wooded habitats.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.) http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRR_P_Species.pdf
Fragrant prickly-apple <i>(Cereus eriophorus var. fragrans)</i>	The plant's favored natural habitat is mostly coastal hammocks with some shade, as the cactus can become desiccated in full sun. Coastal hammocks of this kind have become uncommon as they have been cleared for development and heavily fragmented	The proposed uses of dicamba DGA are not expected to overlap with coastal habitats with shade.	US FWS. 2010. Fragrant prickly-apple (<i>Cereus eriophorus</i> var. <i>fragrans</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3246.pdf
Garber's spurge <i>(Chamaesyce garberi)</i>	Garber's spurge occurs at low elevations either on thin sandy soils composed largely of Pamlico sands or directly on limestone. It is found in a variety of open to moderately shaded habitat types. In pine rocklands, it grows out of crevices in oolitic limestone. On Cape Sable, Everglades NP, it has been reported from hammock edges, open grassy prairies, and backdune swales. In the Florida Keys, it grows on semi-exposed limestone shores, open calcareous salt flats, pine rocklands, calcareous sands	The proposed dicamba DGA uses are not expected to overlap with pine rocklands, limestone crevices, the Everglades National Park, and the Florida Keys.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.) http://ecos.fws.gov/docs/recovery_plan/140903.pdf

	of beach ridges, and along disturbed roadsides.		
Garrett's mint <i>(Dicerandra christmanii)</i>	<i>Dicerandra christmanii</i> is found within openings in sclerophyllous oak scrub. As a gap species, it prefers open areas and does not grow vigorously when in shaded conditions. The habitat is yellow-sand Florida scrub dominated by sand pines (<i>Pinus clausa</i>), several species of oak, and scrub hickory.	The proposed dicamba DGA uses are not expected to overlap with oak scrub, sand pines, and scrub hickory.	US FWS 2009. Garrett's Mint (<i>Dicerandra christmanii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2545.pdf
Godfrey's butterwort <i>(Pinguicula ionantha)</i>	Occurs in herb bog habitats embedded in longleaf pine savannas. Specifically, it is found between a lower elevation habitat dominated by pond cypress overstory and a slightly higher elevation pine flatwoods dominated by an overstory of longleaf pine. This species inhabits seepage bogs, deep swampy bogs, ditches, and depressions in grassy pine flatwoods and savannas (p. 11).	The proposed dicamba DGA uses are not expected to overlap with longleaf pine savannas.	US FWS. 2009. <i>Pinguicula ionantha</i> Godfrey's butterwort 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2590.pdf
Harper's beauty <i>(Harperocallis flava)</i>	Gentle slopes, seepage savannas between pinelands, and cypress swamps to open roadside depressions. Observed in pine flatwoods bog areas surrounded with titi (<i>Cyrilla racemiflora</i>), wiregrass (<i>Aristida stricta</i>), and slash pine (<i>Pinus elliotii</i>), along roadsides, in damp roadside ditches adjacent to planted pines near flatwoods. Wet prairie in transitions to wetter shrub zones and roadside ditches. Wet prairie is characterized as a treeless plain with sparse to dense ground cover of grasses and herbs, dominated by wiregrass in the Apalachicola NF; low relatively flat poorly drained terrain of the coastal plain, seasonally inundated for 50-100 days each years, burns every 2-4 years. Fire prone habitat.	The proposed uses of dicamba DGA are not expected to overlap with savannas and pine flatwoods bog areas.	US FWS. 2009. <i>Harperocallis flava</i> Harper's beauty 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2579.pdf

Highlands scrub hypericum <i>(Hypericum cumulicola)</i>	Highlands scrub hypericum is found almost exclusively in upland areas with excessively-drained white sand. It is found primarily in rosemary scrub but also in xeric scrubby flatwoods. These areas have fire return intervals of 5-30 years or 10-100 years. The species is not found in all areas of suitable habitat probably because of dispersal limitations.	The proposed dicamba DGA uses are not expected to overlap with white sand areas.	US FWS 2008. beauty Highlands scrub hypericum (<i>Hypericum cumulicola</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1959.pdf
Johnson's seagrass <i>(Halophila johnsonii)</i>	Estuarine/Marine Submerged Environments. Lagoons along approximately 200 km of coastline in southeastern Florida between Sebastian Inlet and north Biscayne Bay. Extending from intertidal to 3m of depth	The proposed dicamba DGA uses are not expected to overlap with lagoons and other aquatic habitats.	US FWS. 2002. Endangered and Threatened Species; Notice of Availability for the Final Recovery Plan for Johnson's Seagrass http://ecos.fws.gov/docs/federal_register/fr3965.pdf
Key tree cactus <i>(Pilosocereus robinii)</i>	This cactus grows in upland tropical hardwood hammocks on limestone or coral substrates. It sometimes grows on sparsely vegetated coral rock and just above the high tide mark.	The proposed dicamba DGA uses are not expected to overlap with upland tropical hardwood hammocks on limestone or coral substrates.	US FWS. 2010. Key tree-cactus (<i>Pilosocereus robinii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3278.pdf
Knieskern's Beaked-rush <i>(Rhynchospora knieskernii)</i>	Occurs in groundwater-influenced, fluctuating, successional habitats. Found on bare substrates with sparse vegetation. Requires disturbance and is an early successional species. Historical records indicate species occupied wet open areas in fire-dependent pitch pine forests. Species is now found in human-influenced sites such as the edges of abandoned clay, sand, and gravel pits; borrow pits that are functioning as vernal pools; ditches; unimproved roads; cranberry bogs; and railroad and powerline rights-of-way	The proposed dicamba DGA uses are not expected to overlap with the edges of abandoned clay, sand, and gravel pits; borrow pits that are functioning as vernal pools; ditches; unimproved roads; cranberry bogs; and railroad and powerline rights-of-way.	US FWS. 1993. Knieskern's Beaked-rush (Ii) Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930929b.pdf
Lakela's mint <i>(Dicerandra immaculata)</i>	<i>Dicerandra immaculata</i> is found in open scrub, sand pine scrub, and sandhills on remnants of old coastal dunes.	The proposed uses of dicamba DGA are not expected to overlap with scrub and sandhills habitats.	US FWS. 2008. Lakela's mint (<i>Dicerandra immaculata</i>) 5-Year Review: Summary and Evaluation

			http://ecos.fws.gov/docs/five_year_review/doc1984.pdf
<p>Longspurred mint</p> <p>(<i>Dicerandra cornutissima</i>)</p>	<p>Endemic to sand pine scrub habitat of Florida. Occurs southwest of Ocala in the Sumter Upland in Marion County along and west of Interstate Highway 75 and formerly in northern Sumter County. The longspurred mint prefers sunny spots with bare sand. The plant is restricted to the margins of scrub vegetation that occurs in patches surrounded by long leaf pine-turkey oak sandhill vegetation</p>	<p>The proposed dicamba DGA uses are not expected to overlap with sand pine scrub habitat.</p>	<p>US FWS. 1987. Recovery Plan for Three Florida Mints.</p> <p>http://ecos.fws.gov/docs/recovery_plan/060313d.pdf</p>
<p>Okeechobee gourd</p> <p>(<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>)</p>	<p>Lake Okeechobee and the other along the St. Johns River. Limited to areas along the shoreline and a few islands in the lake and along the St. Johns River</p>	<p>The proposed dicamba DGA uses are not expected to overlap with lakes and rivers.</p>	<p>US FWS. 2009. Okeechobee gourd (<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>) 5-Year Review: Summary and Evaluation</p> <p>http://ecos.fws.gov/docs/five_year_review/doc2583.pdf</p>
<p>Papery whitlow-wort</p> <p>(<i>Paronychia chartacea</i>)</p>	<p>Rosemary scrub, or the rosemary phase of sand pine scrub. The fire cycle in rosemary scrub can range from 10 to as long as 100 years</p> <p>The shrub matrix is interspersed with open sandy areas that contain a cover of herbs and lichens. These gaps are more persistent in rosemary scrubs than in scrubby flatwoods. Within these scrub communities, papery whitlow-wort is more abundant in disturbed, sandy habitats such as road rights-of-way and recently cleared high Pine. In rosemary scrub paper whitlow-wort can become very abundant after a fire or on disturbed sites such as along fire lanes or trails. The subspecies <i>P. chartacea</i> ssp. <i>minima</i> occurs in the Florida panhandle in coarse white sand along margins of</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with rosemary scrub or sand pine scrub.</p>	<p>US FWS. 1999. Multi-Species Recovery Plan for South Florida</p> <p>http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf.</p>

	karst lakes (Anderson 1991). It is apparently favored by mild disturbance. It often occurs in nearly pure stands.		
Pigeon wings (<i>Clitoria fragrans</i>)	Range of xeric upland sites. Primarily in sandhill and oak-hickory scrub or oak scrub.	The proposed dicamba DGA uses are not expected to overlap with sandhill or scrub habitats.	US FWS. 2008. Pigeon wings (<i>Clitoria fragrans</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1976.pdf
Pygmy fringe-tree (<i>Chionanthus pygmaeus</i>)	Inhabits excessively drained sandy soils on the Lake Wales Ridge (and historically on the Mount Dora Range) of central Florida. These high ridges are blanketed with soils that are classified as Quartzipsamments. This species is found on the low-nutrient St. Lucie fine sand which is subject to rapid drying. <i>Chionanthus pygmaeus</i> occurs primarily in scrub as well as high pine, dry hammocks, and transitional habitats. It may form thickets along with evergreen oaks and other shrubs. It may be the dominant plant, co-dominant plant or subdominant plant.	The proposed dicamba DGA uses are not expected to overlap with scrub and hammocks.	US FWS. 1999. Multi-Species Recovery Plan for South Florida http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Rugel's pawpaw (<i>Deeringothamnus rugelii</i>)	Grassy flatlands/mesic/wet flatwoods at Volusia County conservation land. The habitat at this site is dominated by mature longleaf pine and an intact groundcover, which frequently includes wiregrass in abundance. Open sandy patches that have been controlled under natural situations with fire. Fire is needed to create habitat for this species. Slash pine flatwoods with an understory consisting of grasses and sedges	The proposed dicamba DGA uses are not expected to overlap with flatwoods habitats.	US FWS. 2008. Rugel's pawpaw (<i>Deeringothamnus rugelii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1990.pdf
Sandlace (<i>Polygonella myriophylla</i>)	This plant is a member of the Florida scrub plant community. It occurs in dry white-sand scrub dominated by Florida rosemary, as well as oak scrub, flatwoods,	The proposed dicamba DGA uses are not expected to overlap with scrub communities	US FWS. 2010. Sandlace (<i>Polygonella myriophylla</i>) 5-Year Review: Summary and Evaluation.

	roadsides, and occasionally sandhills		http://ecos.fws.gov/docs/five_year_review/doc3277.pdf
Scrub blazingstar <i>(Liatris ohlingerae)</i>	Occurs in rosemary scrub or 'rosemary balds' as they are also known, is a unique community type within the Florida scrub ecosystem. Rosemary scrub is largely dominated by Florida rosemary (<i>Ceratiola ericoides</i>) and has extremely well-drained, droughty, low-nutrient sandy soils. Rosemary scrub appears as small 'islands' separated from each other, often by considerable distances. Scrubby flatwoods often surround rosemary scrub, dominated by clonal oaks (<i>Quercus</i> spp.). Also colonizes anthropogenic sites within its natural habitat, such as fire lanes and roadsides. Occurrences of scrub blazingstar are generally small, with scattered plants at low densities over large areas.	The proposed dicamba DGA uses are not expected to overlap with rosemary scrub or rosemary balds habitat.	US FWS. 2010. Scrub Blazingstar (<i>Liatris ohlingerae</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3269.pdf
Scrub buckwheat <i>(Eriogonum longifolium</i> var. <i>gnaphalifolium)</i>	Scrub buckwheat occurs in habitats intermediate between scrub and sandhills (high pine) and in turkey oak barrens from Putnam County to Highlands County).	The proposed dicamba DGA uses are not expected to overlap with scrub and sandhills habitat.	US FWS. 2010. Scrub buckwheat (<i>Eriogonum longifolium</i> var. <i>gnaphalifolium</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1926.pdf
Scrub lupine <i>(Lupinus aridorum)</i>	Coastal scrub habitat in two distinct areas: Western Orange County (Orlando area) and North-central Polk County on the Winter Haven Ridge near Auburndale and Winter Haven, on sites that total only about 540 acres.	The proposed dicamba DGA uses are not expected to overlap with coastal scrub habitat.	US FWS. 1996. Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species. http://ecos.fws.gov/docs/recovery_plan/960622.pdf
Scrub plum <i>(Prunus geniculata)</i>	Found in both scrub and high pineland. It should probably be sought in ecotones or scrubby high pineland. (pg. 33)	The proposed dicamba DGA uses are not expected to overlap with scrub and high pineland.	US FWS. 1996. Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species. http://ecos.fws.gov/docs/recovery_plan/960622.pdf

Short-leaved rosemary (<i>Conradina brevifolia</i>)	This plant grows in Florida scrub habitat on white sand substrates among sand pines and oaks.	The proposed dicamba DGA uses are not expected to overlap with scrub habitat.	US FWS. 2008. Short-leaved rosemary (<i>Conradina brevifolia</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1943.pdf
Small's milkpea (<i>Galactia smallii</i>)	Pine Rockland habitat. Small's milkpea prefers open sun and little shade and can be threatened by shading from hardwoods and displacement by invasive exotic species in the absence of periodic fires. Disturbance, such as prescribed fire, is a necessary management tool to maintain suitable habitat for the species	The proposed dicamba DGA uses are not expected to overlap with pine rockland habitat.	US FWS. 2010. Small's Milkpea (<i>Galactia smallii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3257.pdf
Snakeroot (<i>Eryngium cuneifolium</i>)	Open sand gaps in white sand scrub, primarily Florida rosemary scrub 'balds', characterized by xeric conditions, relatively sparse vegetation, persistent gaps, and longer fire-return intervals than oak (<i>Quercus</i> spp.) and sand pine (<i>Pinus clausa</i>) dominated scrubs (pg. 6); restricted to open areas of well-drained white sand in Florida rosemary scrub that is very xeric with persistent gaps and longer fire-return intervals than other types of scrub (pg. 11)	The proposed dicamba DGA uses are not expected to overlap with scrub habitats.	US FWS. 2010. Snakeroot (<i>Eryngium cuneifolium</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3248.pdf
Telephus spurge (<i>Euphorbia telephioides</i>)	Xeric to mesic pine flatwoods and in scrubby pinewoods. Occasionally found in wetlands with seepage slope species and in small clumps of wiregrass surrounded by cyprus or pine.	The proposed dicamba DGA uses are not expected to overlap with woods or wetlands.	US. FWS. 2008. Euphorbia telephioides (<i>Telephus spurge</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1884.pdf
Tiny polygala (<i>Polygala smallii</i>)	Occurs in four distinct habitats with similar characteristics: pine rockland, scrub, high pine, and open coastal spoil which are pyrogenic-extremely dry and prone to periodic natural fire.	The proposed dicamba DGA uses are not expected to overlap with pine rockland, scrub, high pine, and open coastal spoil.	US FWS. 1999. Multi-Species Recovery Plan for South Florida http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
White birds-in-a-nest (<i>Macbridea alba</i>)	In general, plants are found in mesic pine flatwoods, wet savannas, seepage slopes, and ecotones between pine flatwoods and titi-swamps. The wettest sites occupied by	The proposed dicamba DGA salt uses are not expected to overlap with mesic pine flatwoods, wet	US FWS. 2009. <i>Macbridea alba</i> (White birds-in-a-nest) 5-Year Review: Summary and Evaluation

	these plants are grassy seepage bogs on gentle slopes at the edge of forested or shrubby wetlands. White birds-in-a-nest also occurs in drier sites along longleaf pine and runner oaks, as well as along associated roadsides.	savannas and seepage slopes.	http://ecos.fws.gov/docs/five_year_review/doc2371.pdf
Wide-leaf warea <i>(Warea amplexifolia)</i>	Endemic to the high pine (or sandhill) habitat of Lake Wales Ridge in Lake, Polk, Osceola, and Orange County, FL. This habitat has a relatively high diversity of herbaceous ground cover maintained by patchy summer fires sparked by lightning. It grows well in open, sandy patches and does not tolerate shading by dense shrubs or trees.	The proposed dicamba DGA uses are not expected to overlap with pine habitat.	US FWS. 2007. Wide-leaf warea <i>(Warea amplexifolia)</i> 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1096.pdf
Wireweed <i>(Polygonella basiramia)</i>	It occurs in scrub dominated by Florida rosemary, sand pine, other pines, and oaks. The plant occurs in openings in the scrub which are maintained by periodic wildfires. Other plants in this habitat include <i>Calamintha ashei</i> , <i>Cnidoscolus stimulosus</i> , <i>Eryngium cuneifolium</i> , <i>Euphorbia floridana</i> , <i>Hypericum cumulicola</i> , <i>Lechea cernua</i> , <i>Licania michauxii</i> , <i>Paronychia chartacea</i> , <i>Polanisia tenuifolia</i> , <i>Polygonella polygama</i> , <i>Selagniella arenicola</i> , and <i>Stipulicida setacea</i>	The proposed dicamba DGA uses are not expected to overlap with scrub habitat.	US FWS. 2010. Wireweed <i>(Polygonella basiramia)</i> 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3280.pdf

Appendix 3

Critical Habitat Designations and PCE Descriptions

Summary of 14 Listed Species Identified as being on Agricultural Fields with and without Critical Habitat Designations for the 11 States (AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA, WV) Assessed for Dicamba DGA salt

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species with Critical Habitat Designations (6 Species)</i> ³		
California condor (<i>Gymnogyps californianus</i>)	PCEs: The following areas of land, water and airspace with spatial bounds described in the critical habitat source documentation: Sespe-Piru Condor Area, Matillija Condor Area, Sisquoc-San Rafael Condor Area, Mountain-Beartrap Condor Area, Mt. Pinos Condor Area, Blue Ridge Condor Area, Tejon Ranch, Kern County rangelands and Tulare County rangelands.	http://ecos.fws.gov/docs/federal_register/fr161.pdf
Gray wolf (<i>Canis lupis</i>)	PCE: Not specified.	http://ecos.fws.gov/docs/federal_register/fr186.pdf
Indiana bat (<i>Myotis sodalis</i>)	Critical habitat designations are either mines or caves.	http://ecos.fws.gov/docs/federal_register/fr161.pdf
Jaguar (<i>Panthera onca</i>)	PCEs: Expansive open spaces in the southwestern United States of at least 100 km ² (38.6 mi ²) in size which: (1) Provide connectivity to Mexico; (2) Contain adequate levels of native prey species, including deer and javelina, as well as medium-sized prey such as coatis, skunks, raccoons, or jackrabbits; (3) Include surface water sources available within 20 km (12.4 mi) of each other; (4) Contain from greater than 1 to 50 percent canopy cover within Madrean evergreen woodland, generally recognized by a mixture of oak (<i>Quercus</i> spp.), juniper (<i>Juniperus</i> spp.), and pine (<i>Pinus</i> spp.) trees on the landscape, or semidesert grassland vegetation communities, usually characterized by <i>Pleuraphis mutica</i> (tobosagrass) or <i>Bouteloua eriopoda</i> (black grama) along with other grasses; (5) Are characterized by intermediately, moderately, or highly rugged terrain; (6) Are below 2,000 m (6,562 feet) in elevation; and (7) Are characterized by minimal to no human population density, no major roads, or no stable nighttime lighting over any 1-km ² (0.4-mi ²) area.	http://www.gpo.gov/fdsys/pkg/FR-2014-03-05/pdf/2014-03485.pdf
Virginia big-eared bat (<i>Corynorhinus</i> (=Plecotus) <i>townsendii virginianus</i>)	Critical habitat designations are caves.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A080#crithab http://ecos.fws.gov/docs/federal_register/fr366.pdf
Whooping crane (<i>Grus americana</i>)	PCE: All areas proposed in this rule would provide food, water, and other nutritional or physiological needs of the	http://ecos.fws.gov/docs/federal_register/fr237.pdf

³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

	whooping crane during spring or fall migration. Consumption of some cereal crops in adjacent croplands during migration period. Direct relatable resources to agricultural field possibly treated with 2,4-D choline.	
<i>Species without critical habitat designations (8 species)</i>		
Audubon crested caracara (<i>Polyborus plancus audubonii</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B06Q
Delmarva Peninsula fox squirrel (<i>Sciurus niger cinereus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00B
Eastern indigo snake (<i>Drymarchon corais couperi</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C026#crithab
Florida panther (<i>Puma (=Felis) concolor coryi</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A008
Lesser prairie-chicken (<i>Tympanuchus pallidicinctus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0AZ#crithab
Ocelot (<i>Leopardus (Felis) pardalis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A084#crithab
Red wolf (<i>Canis rufus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00F#crithab
Sonoran pronghorn (<i>Antilocapra americana sonoriensis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A009

Summary of Listed Species Identified as being off Agricultural Fields without Critical Habitat⁴ (191 species)

Alamosa springsnail (<i>Tryonia alamosae</i>)
American chaffseed (<i>Schwalbea americana</i>)
American hart's-tongue fern (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)
Anastasia Island beach mouse (<i>Peromyscus polionotus phasma</i>)
Apache trout (<i>Oncorhynchus apache</i>)
Apalachicola rosemary (<i>Conradina glabra</i>)
Appalachian Monkeyface, Appalachian (pearly mussel) (<i>Quadrula sparsa</i>)
Arizona Cliff-rose (<i>Purshia</i> (= <i>Cowania</i>) <i>subintegra</i>)
Arizona hedgehog cactus (<i>Echinocereus triglochidiatus</i> var. <i>arizonicus</i>)
Atlantic salt marsh snake (<i>Nerodia clarkii taeniata</i>)
Avon Park harebells (<i>Crotalaria avonensis</i>)
Bachman's warbler (= wood) (<i>Vermivora bachmanii</i>)
Beach jacquemontii (<i>Jacquemontia reclinata</i>)
Beautiful pawpaw (<i>Deeringothamnus pulchellus</i>)
Birdwing pearly mussel (<i>Lemiox rimosus</i>)
Black-footed ferret (<i>Mustela nigripes</i>)
Blackside dace (<i>Phoxinus cumberlandensis</i>)
Bluetail mole skink (<i>Eumeces egregius lividus</i>)
Bog (= Muhlenberg) turtle (<i>Clemmys muhlenbergii</i>)
Brady pincushion cactus (<i>Pediocactus bradyi</i>)
Britton's beargrass (<i>Nolina brittoniana</i>)
Brooksville bellflower (<i>Campanula robinsiae</i>)
California least tern (<i>Sterna antillarum browni</i>)
Canada lynx (<i>Lynx canadensis</i>)
Canby's dropwort (<i>Oxypolis canbyi</i>)
Canelo Hills ladies'-tresses (<i>Spiranthes delitescens</i>)
Carolina northern flying squirrel (<i>Glaucomys sabrinus coloratus</i>)
Carter's mustard (<i>Warea carteri</i>)
Chapman rhododendron (<i>Rhododendron chapmanii</i>)
Cheat Mountain salamander (<i>Plethodon nettingi</i>)
Chittenango ovate amber snail (<i>Succinea chittenangoensis</i>)
Clubshell (<i>Pleurobema clava</i>)
Cochise pincushion cactus (<i>Coryphantha robbinsorum</i>)
Colorado hookless cactus (<i>Sclerocactus glaucus</i>)
Cooley's meadowrue (<i>Thalictrum cooleyi</i>)
Cooley's water-willow (<i>Justicia cooleyi</i>)
Cracking pearly mussel (<i>Hemistena lata</i>)
Crenulate lead-plant (<i>Amorpha crenulata</i>)
Cumberland bean (pearly mussel) (<i>Villosa trabalis</i>)
Cumberland monkeyface (pearly mussel) (<i>Quadrula intermedia</i>)
Deltoid spurge (<i>Chamaesyce deltoidea</i> ssp. <i>deltoidea</i>)
Dromedary pearly mussel (<i>Dromus dromas</i>)
Dudley Bluffs bladderpod (<i>Lesquerella congesta</i>)
Dudley Bluffs twinpod (<i>Physaria obcordata</i>)
Duskytail darter (<i>Etheostoma percnurum</i>)
Dwarf wedgemussel (<i>Alasmidonta heterodon</i>)
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)

⁴ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Etonia rosemary (<i>Conradina etonia</i>)
Fanshell (<i>Cyprogenia stegaria</i>)
Finback whale (<i>Balaenoptera physalus</i>)
Finerayed pigtoe (<i>Fusconaia cuneolus</i>)
Flat-spired three-toothed snail (<i>Triodopsis platysayoides</i>)
Florida bonamia (<i>Bonamia grandiflora</i>)
Florida Bonneted bat (<i>Eumops floridanus</i>)
Florida golden aster (<i>Chrysopsis floridana</i>)
Florida grasshopper sparrow (<i>Ammodramus savannarum floridanus</i>)
Florida perforate cladonia (<i>Cladonia perforata</i>)
Florida salt marsh vole (<i>Microtus pennsylvanicus dukecampbelli</i>)
Florida scrub-jay (<i>Aphelocoma coerulescens</i>)
Florida skullcap (<i>Scutellaria floridana</i>)
Florida torreyia (<i>Torreya taxifolia</i>)
Florida ziziphus (<i>Ziziphus celata</i>)
Four-petal pawpaw (<i>Asimina tetramera</i>)
Fragrant prickly-apple (<i>Cereus eriophorus</i> var. <i>fragrans</i>)
Fringed campion (<i>Silene polypetala</i>)
Garber's spurge (<i>Chamaesyce garberi</i>)
Garrett's mint (<i>Dicerandra christmanii</i>)
Gentian pinkroot (<i>Spigelia gentianoides</i>)
Gila topminnow (incl. Yaqui)(<i>Poeciliopsis occidentalis</i>)
Gila trout (<i>Oncorhynchus gilae</i>)
Godfrey's butterwort (<i>Pinguicula ionantha</i>)
Gray bat (<i>Myotis grisescens</i>)
Green blossom (pearly mussel)(<i>Epioblasma torulosa gubernaculum</i>)
Greenback Cutthroat trout (<i>Oncorhynchus clarki stomias</i>)
Harperella (<i>Ptilimnium nodosum</i>)
Harper's beauty (<i>Harperocallis flava</i>)
Hay's Spring amphipod (<i>Stygobromus hayi</i>)
Highlands scrub hypericum (<i>Hypericum cumulicola</i>)
Holy Ghost ipomopsis (<i>Ipomopsis sancti-spiritus</i>)
Houghton's goldenrod (<i>Solidago houghtonii</i>)
Hualapai Mexican vole (<i>Microtus mexicanus hualpaiensis</i>)
Humpback whale (<i>Megaptera novaeangliae</i>)
James spiny mussel (<i>Pleurobema collina</i>)
Jones cycladenia (<i>Cycladenia humilis</i> var. <i>jonesii</i>)
Kearney's blue-star (<i>Amsonia kearneyana</i>)
Kemp's ridley sea turtle (<i>Lepidochelys kempii</i>)
Key deer (<i>Odocoileus virginianus clavium</i>)
Key tree cactus (<i>Pilosocereus robinii</i>)
Kirtland's warbler (<i>Setophaga kirtlandii</i>)
Knieskern's beaked-rush (<i>Rhynchospora knieskernii</i>)
Knowlton's cactus (<i>Pediocactus knowltonii</i>)
Kuenzler hedgehog cactus (<i>Echinocereus fendleri</i> var. <i>kuenzleri</i>)
Lakela's mint (<i>Dicerandra immaculata</i>)
Least tern (<i>Sterna antillarum</i>)
Lee County cave isopod (<i>Lirceus usdagalun</i>)
Leedy's Roseroot (<i>Rhodiola integrifolia</i> ssp. <i>leedyi</i>)
Lee pincushion cactus (<i>Coryphantha sneedii</i> var. <i>leei</i>)
Lewton's polygala (<i>Polygala lewtonii</i>)
Littlewing pearly mussel (<i>Pegias fabula</i>)
Longspurred mint (<i>Dicerandra cornutissima</i>)

Lower Keys marsh rabbit (<i>Sylvilagus palustris hefneri</i>)
Madison Cave isopod (<i>Antrolana lira</i>)
Mancos milk-vetch (<i>Astragalus humillimus</i>)
Masked bobwhite (quail) (<i>Colinus virginianus ridgwayi</i>)
Mesa Verde cactus (<i>Sclerocactus mesae-verdae</i>)
Miami Blue Butterfly (<i>Cyclargus</i> (= <i>Hemiargus</i>) <i>thomasi bethunebakeri</i>)
Miccosukee gooseberry (<i>Ribes echinellum</i>)
Michaux's sumac (<i>Rhus michauxii</i>)
Mitchell's satyr butterfly (<i>Neonympha mitchellii mitchellii</i>)
Nichol's Turk's head cactus (<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>)
North Park phacelia (<i>Phacelia formosula</i>)
Northeastern beach tiger beetle (<i>Cicindela dorsalis dorsalis</i>)
Northeastern bulrush (<i>Scirpus ancistrochaetus</i>)
Northern monkshood (<i>Aconitum noveboracense</i>)
Northern riffleshell (<i>Epioblasma torulosa rangiana</i>)
Okaloosa darter (<i>Etheostoma okaloosae</i>)
Okeechobee gourd (<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>)
Osterhout milkvetch (<i>Astragalus osterhoutii</i>)
Papery whitlow-wort (<i>Paronychia chartacea</i>)
Pecos gambusia (<i>Gambusia nobilis</i>)
Peebles Navajo cactus (<i>Pediocactus peeblesianus</i> var. <i>peeblesianus</i>)
Penland alpine fen mustard (<i>Eutrema penlandii</i>)
Penland beardtongue (<i>Penstemon penlandii</i>)
Peter's mountain mallow (<i>Iliamna corei</i>)
Pigeon wings (<i>Clitoria fragrans</i>)
Pima pineapple cactus (<i>Coryphantha scheeri</i> var. <i>robustispina</i>)
Pink mucket (pearly mussel) (<i>Lampsilis abrupta</i>)
Puritan tiger beetle (<i>Cicindela puritana</i>)
Pygmy fringe-tree (<i>Chionanthus pygmaeus</i>)
Rayed bean (<i>Villosa fabalis</i>)
Red-cockaded woodpecker (<i>Picoides borealis</i>)
Roan Mountain bluet (<i>Hedyotis purpurea</i> var. <i>montana</i>)
Roanoke logperch (<i>Percina rex</i>)
Rock gnome lichen (<i>Gymnoderma lineare</i>)
Roseate tern (<i>Sterna dougallii dougallii</i>)
Rough pigtoe (<i>Pleurobema plenum</i>)
Rugel's pawpaw (<i>Deeringothamnus rugelii</i>)
Running buffalo clover (<i>Trifolium stoloniferum</i>)
Sacramento prickly poppy (<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>)
Sand skink (<i>Neoseps reynoldsi</i>)
Sandlace (<i>Polygonella myriophylla</i>)
Sandplain gerardii (<i>Agalinis acuta</i>)
Schaus swallowtail butterfly (<i>Heraclides aristodemus ponceanus</i>)
Scrub blazingstar (<i>Liatris ohlingerae</i>)
Scrub buckwheat (<i>Eriogonum longifolium</i> var. <i>gnaphalifolium</i>)
Scrub lupine (<i>Lupinus aridorum</i>)
Scrub mint (<i>Dicerandra frutescens</i>)
Scrub plum (<i>Prunus geniculata</i>)
Seabeach amaranth (<i>Amaranthus pumilus</i>)
Sensitive joint-vetch (<i>Aeschynomene virginica</i>)
Sentry milk-vetch (<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>)
Shale barren rock cress (<i>Arabis serotina</i>)
Sheepnose mussel (<i>Plethobasus cyphus</i>)

Shenandoah salamander (<i>Plethodon shenandoah</i>)
Shiny pigtoe (<i>Fusconaia cor</i>)
Short-leaved rosemary (<i>Conradina brevifolia</i>)
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)
Siler pincushion cactus (<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>)
Small whorled pogonia (<i>Isotria medeoloides</i>)
Small-anthered bittercress (<i>Cardamine micranthera</i>)
Small's milkpea (<i>Galactia smallii</i>)
Smalltooth sawfish (<i>Pristis pectinata</i>)
Smooth coneflower (<i>Echinacea laevigata</i>)
Snakeroot (<i>Eryngium cuneifolium</i>)
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)
Snuffbox mussel (<i>Epioblasma triquetra</i>)
Socorro isopod (<i>Thermosphaeroma thermophilus</i>)
Socorro springsnail (<i>Pyrgulopsis neomexicana</i>)
Sonora tiger Salamander (<i>Ambystoma tigrinum stebbinsi</i>)
Southeastern beach mouse (<i>Peromyscus polionotus niveiventris</i>)
Southern sandshell (<i>Hamiota</i> (= <i>Lampsilis</i>) <i>australis</i>)
Spectaclecase (mussel) (<i>Cumberlandia monodonta</i>)
Squirrel Chimney Cave shrimp (<i>Palaemonetes cumingii</i>)
Stock Island tree snail (<i>Orthalicus reses</i>)
Swamp pink (<i>Helonias bullata</i>)
Tan Riffleshell (<i>Epioblasma florentina walkeri</i> (= <i>E. walkeri</i>))
Telephus spurge (<i>Euphorbia telephioides</i>)
Tiny polygala (<i>Polygala smallii</i>)
Tubercled blossom (pearly mussel) (<i>Epioblasma torulosa torulosa</i>)
Uncompahgre fritillary butterfly (<i>Boloria acrocneuma</i>)
Ute Ladies'-Tresses, (<i>Spiranthes diluvialis</i>)
Virginia fringed mountain snail (<i>Polygyriscus virginianus</i>)
Virginia round-leaf birch (<i>Betula uber</i>)
Virginia sneezeweed (<i>Helenium virginicum</i>)
Virginia spiraea (<i>Spiraea virginiana</i>)
White birds-in-a-nest (<i>Macbridea alba</i>)
Wide-leaf warea (<i>Warea amplexifolia</i>)
Wireweed (<i>Polygonella basiramia</i>)
Wood stork (<i>Mycteria americana</i>)
Yuma clapper rail (<i>Rallus longirostris yumanensis</i>)
Zuni fleabane (<i>Erigeron rhizomatus</i>)

Summary of Listed Species Identified as being off Agricultural Fields with Critical Habitat⁵ (117 species)

Aboriginal prickly-apple (<i>Harrisia aboriginum</i>)
Acuna Cactus (<i>Echinomastus erectocentrus</i> var. <i>acunensis</i>)
American crocodile (<i>Crocodylus acutus</i>)
Arkansas River shiner (<i>Notropis girardi</i>)
Bartram's Hairstreak Butterfly (<i>Strymon acis bartrami</i>)
Beautiful shiner (<i>Cyprinella formosa</i>)
Bonytail chub (<i>Gila elegans</i>)

⁵ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Cape Sable seaside sparrow (<i>Ammodramus maritimus mirabilis</i>)
Cape Sable thoroughwort (<i>Chromolaena frustrata</i>)
Carter's small-flowered flax (<i>Linum carteri carteri</i>)—(proposed)
Chihuahua chub (<i>Gila nigrescens</i>)
Chipola slabshell (<i>Elliptio chipolaensis</i>)
Chiricahua leopard frog (<i>Rana</i> (= <i>Lithobates</i>) <i>chiricahuensis</i>)
Choctaw bean (<i>Villosa choctawensis</i>)
Choctawhatchee beach mouse (<i>Peromyscus polionotus allopshys</i>)
Chupadera springsnail (<i>Pyrgulopsis chupaderae</i>)
Clay-loving wild buckwheat (<i>Eriogonum pelinophilum</i>)
Colorado Butterfly Plant (<i>Gaura neomexicana</i> var. <i>coloradensis</i>)
Colorado pikeminnow (=squawfish)(<i>Ptychocheilus lucius</i>)
Cumberlandian combshell (<i>Epioblasma brevidens</i>)
DeBeque phacelia (<i>Phacelia submutica</i>)
Desert tortoise (<i>Gopherus agassizii</i>)
Desert pupfish (<i>Cyprinodon macularius</i>)
Diamond darter (<i>Crystallaria cincotta</i>)
Elkhorn coral (<i>Acropora palmate</i>)
Everglade snail kite (<i>Rostrhamus sociabilis plumbeus</i>)
Fat three-ridge (mussel) (<i>Amblema neislerii</i>)
Fickeisen Plains cactus (<i>Pediocactus peeblesianus fickeiseniae</i>)
Florida brickell-bush (<i>Brickellia mosieri</i>)—(Proposed)
Florida Leafwing Butterfly (<i>Anaea troglodyta floridalis</i>)
Florida semaphore cactus (<i>Consolea corallicola</i>)
Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)
Frosted flatwoods salamander (<i>Ambystoma cingulatum</i>)
Fuzzy pigtoe (<i>Pleurobema strodeanum</i>)
Gierisch mallow (<i>Sphaeralcea gierischii</i>)
Gila chub (<i>Gila intermedia</i>)
Green sea turtle (<i>Chelonia mydas</i>)
Gulf moccasinshell (<i>Medionidus penicillatus</i>)
Gulf sturgeon (<i>Acipenser oxyrinchus desotoi</i>)
Gypsum wild-buckwheat (<i>Eriogonum gypsophilum</i>)
Hawksbill sea turtle (<i>Eretmochelys imbricata</i>)
Holmgren milk-vetch (<i>Astragalus holmgreniorum</i>)
Huachuca water-umbel (<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>)
Humpback chub (<i>Gila cypha</i>)
Jemez Mountains salamander (<i>Plethodon neomexicanus</i>)
Johnson's seagrass (<i>Halophila johnsonii</i>)
Kanab ambersnail (<i>Oxyloma haydeni kanabensis</i>)—(proposed)
Karner blue butterfly (<i>Lycaeides melissa samuelis</i>)
Key Largo cotton mouse (<i>Peromyscus gossypinus allapaticola</i>)—(proposed)
Key Largo woodrat (<i>Neotoma floridana smalli</i>)
Koster's springsnail (<i>Juturnia kosteri</i>)
Leatherback sea turtle (<i>Dermochelys coriacea</i>)
Lesser long-nosed bat (<i>Leptonycteris curasoae yerbabuenae</i>)
Little Colorado spinedace (<i>Lepidomeda vittata</i>)
Loach minnow (<i>Tiaroga cobitis</i>)
Loggerhead sea turtle (<i>Caretta caretta</i>)
Maryland darter (<i>Etheostoma sellare</i>)
Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)
Mexican spotted owl (<i>Strix occidentalis lucida</i>)
Mount Graham red squirrel (<i>Tamiasciurus hudsonicus grahamensis</i>)

Narrow pigtoe (<i>Fusconaia escambia</i>)
Narrow-headed gartersnake (<i>Thamnophis rufipunctatus</i>)—(Proposed)
Navajo sedge (<i>Carex specuicola</i>)
New Mexican ridge-nosed rattlesnake (<i>Crotalus willardi obscurus</i>)
New Mexico meadow jumping mouse (<i>Zapus hudsonius luteus</i>)—(Proposed)
Noel's amphipod (<i>Gammarus desperatus</i>)
North Atlantic right whale (<i>Eubalaena glacialis</i>)
Northern Mexican gartersnake (<i>Thamnophis eques megalops</i>)—(Proposed)
Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)
Oval pigtoe (<i>Pleurobema pyriforme pyriforme</i>)
Ovate clubshell (<i>Pleurobema perovatum</i>)
Oyster mussel (<i>Epioblasma capsaeformis</i>)
Pagosa skyrocket (<i>Ipomopsis polyantha</i>)
Parachute beardtongue (<i>Penstemon debilis</i>)
Pawnee montane skipper (<i>Hesperia leonardus montana</i>)
Pecos (=puzzle, =paradox) sunflower (<i>Helianthus paradoxus</i>)
Pecos assiminea snail (<i>Assiminea pecos</i>)
Pecos bluntnose shiner (<i>Notropis simus pecosensis</i>)
Perdido Key beach mouse (<i>Peromyscus polionotus trissyllepsis</i>)
Piping plover (<i>Charadrius melodus</i>)
Preble's meadow jumping mouse (<i>Zapus hudsonius preblei</i>)
Purple bankclimber (mussel) (<i>Elliptoideus sloatianus</i>)
Bean, Purple (<i>Villosa perpurpurea</i>)
Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)
Razorback sucker (<i>Xyrauchen texanus</i>)
Reticulated flatwoods salamander (<i>Ambystoma bishopi</i>)
Rice rat (<i>Oryzomys palustris natator</i>)
Rio Grande silvery minnow (<i>Hybognathus amarus</i>)
Roswell springsnail (<i>Pyrgulopsis roswellensis</i>)
Rough rabbitsfoot (<i>Quadrula cylindrica strigillata</i>)
Round ebonyshell (<i>Fusconaia rotulata</i>)
Sacramento Mountains thistle (<i>Cirsium vinaceum</i>)
San Bernardino springsnail (<i>Pyrgulopsis bernardina</i>)
San Francisco Peaks ragwort (<i>Packera franciscana</i>)
Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)
Slabside pearlymussel (<i>Pleuronaia dolabelloides</i>)
Slender chub (<i>Erimystax cahni</i>)
Smalleye shiner (<i>Notropis buccula</i>)
Sonora chub (<i>Gila ditaenia</i>)
Southern kidneyshell (<i>Ptychobranthus jonesi</i>)
Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)
Spikedace (<i>Meda fulgida</i>)
Spotfin chub (<i>Erimonax monachus</i>)
Spruce-fir moss spider (<i>Microhexura montivaga</i>)
St. Andrew beach mouse (<i>Peromyscus polionotus peninsularis</i>)
Staghorn coral (<i>Acropora cervicornis</i>)
Tapered pigtoe (<i>Fusconaia burkei</i>)
Three Forks Springsnail (<i>Pyrgulopsis trivialis</i>)
Todsen's pennyroyal (<i>Hedeoma todsenii</i>)
Virgin River Chub (<i>Gila seminuda</i> (=robusta))
West Indian manatee (<i>Trichechus manatus latirostris</i>)
Welsh's milkweed (<i>Asclepias welshii</i>)
Woundfin (<i>Plagopterus argentissimus</i>)

Yaqui catfish (<i>Ictalurus pricei</i>)
Yaqui chub (<i>Gila purpurea</i>)
Yellowfin Madtom (<i>Noturus flavipinnis</i>)
Zuni bluehead sucker (<i>Catostomus discobolus yarrowi</i>)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *EW* 3/24/16
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William P. Eckel, Ph.D., Senior Science Advisor *WPE* (For BE) 3-24-16
Amy Blankinship, Senior Science Advisor *AB*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II[®] XTENDFLEX[™] cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bce)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

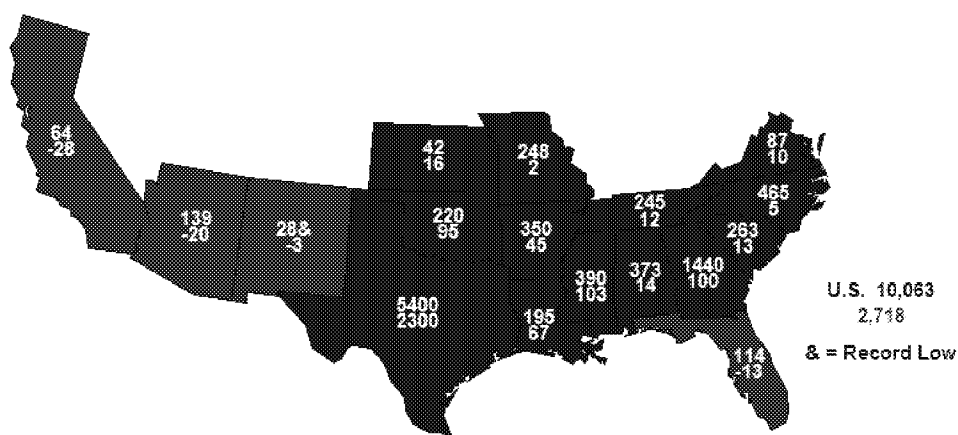
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3 and 4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _∞ (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and ***bold italicized*** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
Medium (35g)	Arthropod	0.0143	4.19	17.58	0.24
	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
Large (1000g)	Arthropod	0.0231	2.90	14.23	0.20
	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 ($>100/42 = >2.38$).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-course droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTI11004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, than given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	
Seed Treatment? (Check if yes)	<input type="checkbox"/>	Seeding Rate (lbs/acre)
Use:	cotton, all or unspecified	18.9
Product name and form:		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%	
Half-life (days):	8.4	
Are you assessing applications with variable rates or intervals?	yes	

For HETI specify application day at Column F and % of day for up to 30 applications

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
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30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	Optional Test Species Name
Mammalian			
Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	Reference (MRID)
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

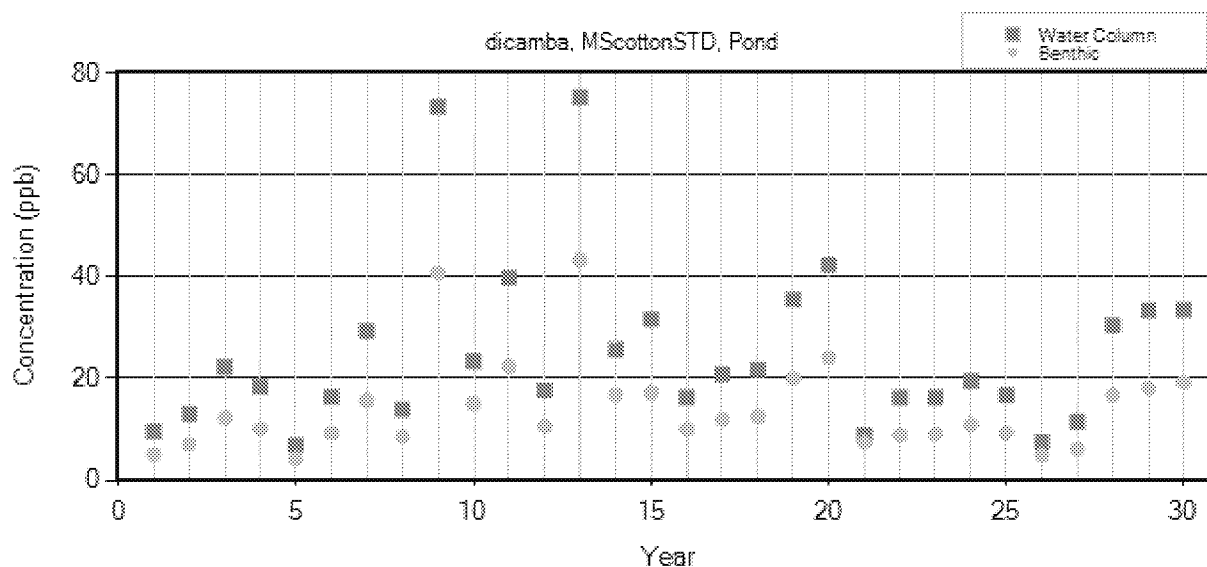


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

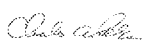
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The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 ug/m³ less than the air concentration required to exceed the EC₂₅ (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 µg/m²•s⁻¹, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 ug/m³ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC₂₅). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC₂₅ at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

References:

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean

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THRU: Mark Corbin, Branch Chief *Mark Corbin 3-24-16*
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This is an addendum to the Environmental Fate and Effects Division's (EFED) ecological risk assessment for dicamba DGA salt (Clarity[®] formulation or M169I, EPA Reg No. 524-582) and its degradate, 3,6-dichlorosalicylic acid (DCSA), for the proposed new use on dicamba-tolerant soybean. It includes analysis of information that was not previously included in the original soybean new use risk assessment (USEPA, 2011, DP 378444). Since the original risk assessment was conducted, the registrant, Monsanto, has submitted:

- 1) field trial data that impacts EFED's previous analysis of spray drift,
- 2) data for incidents and inquiries from the use of dicamba DGA salt,

- 3) laboratory volatility data for dicamba DGA and DMA salt formulations, and
- 4) terrestrial plant reproductive effects data.

Additionally, this addendum includes analysis conducted by EFED regarding:

- 5) the implication of new mammalian chronic effects endpoints for parent dicamba and the metabolite DCSA from the Health Effects Division (HED; USEPA 2016, D378366+),
- 6) a revised T-REX run using refined estimates of foliar dissipation half-lives and variable application rates,
- 7) the potential for effects to beneficial terrestrial invertebrates,
- 8) effects posed by runoff, and
- 9) potential synergistic interactions with glyphosate.

1. Spray Drift and Buffers (Field Trial Data)

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that the distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate). However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect

distance for sensitive plants (the “no-effect” distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto’s statement that the field trial data are not suitable for use in EPA’s regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical

endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED's Process to Determine a "No Effect" Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered "controls," though there are considerable uncertainties to this approach. Specifically, no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these "controls" the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the "control" means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a "no effect" distance at each site was considered the first distance greater than the maximum distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the "no effect" distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.e./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 1. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than only 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Weight of Evidence Conclusions

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of this field trial data is not suitable for the purpose of establishing an appropriate buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.e./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTII 1004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate and with the described nozzles restricting the droplet spectra extra-coarse and ultra-coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

2. Incidents

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in

place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (e.g. burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (e.g. leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EIIIS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. The air temperature and humidity at the time of dicamba application were reported to be 82°F and 55%, respectively. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8

µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements, as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty whether this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing. Further discussion of volatility is provided in **Section 3** below.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where "dicamba type" damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto's submitted information on the 73 incidents from 2012-2014 (discussed previously in this section). With the current information available, and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri). The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made.

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that were not followed included tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants, and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize since the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more likely impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory data conditions. Additional discussion and characterization of volatility is provided in the next section.

3. Volatility

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, because these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 lb a.e./A application rate and 220 feet for the 1.0 lb a.e./A application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However, consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the previous section (MO Case File #81513M00701, EHS Incident report number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (e.g. cooler temperatures)

4. Potential Effects on Terrestrial Plant Reproduction

EFED is aware of published literature associating dicamba applications with effects to soybean progeny. These studies indicate potential effects to the quantity and reproductive quality of future soybean generations following dicamba applications that would not be observed in the guideline vegetative vigor and seedling emergence studies EFED typically uses to assess risk to terrestrial plants. Therefore, these data raise a potential concern that has not been directly addressed in OPP assessments, should these effects occur at lower exposures than the effects observed in the guideline terrestrial plant studies. In meetings and email correspondence in January/February, 2015, OPP asked whether Monsanto was aware of this issue. Monsanto requested the references that OPP was aware of, so that they could independently review them.

Monsanto reviewed the open literature references provided by OPP and stated that none of the studies described effects on progeny at application rates lower than OPP's lowest available regulatory endpoint from the available vegetative vigor plant study (0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), therefore any mitigations (*i.e.* spray drift buffers) based on the plant height endpoint would be protective for effects to progeny.

The open literature studies examined seeds/pod, seed weight, seed quality, delayed maturation, pod malformation, reduced germination or progeny emergence, and malformed progeny. The vast majority of the studies did not investigate effects at rates as low as the NOAEC from the available vegetative vigor study. Monsanto's review of the available information indicated that the lowest effects endpoint reported from these studies was for delayed maturation of soybeans at rates as low as 0.56 g a.e./A from Kelley *et al.* (2005), which would still be almost 2 times less sensitive than the regulatory endpoint based on plant height that EFED has used in its risk assessments. Monsanto concluded that the open literature studies did not contain information that indicated that the in-field buffer based on plant height that is on the draft label would not also be protective of these reproductive effects.

EFED acknowledges Monsanto's submission of their analysis of the open literature data for effects to progeny, but to date has not independently reviewed each of these studies. However, for the following reason, EFED does not believe the information would change its risk assessments. The most sensitive endpoint reported in the open literature was a LOAEC of 0.56 g a.e./A for delayed maturation of soybeans (Kelley *et al.*, 2005; no NOAEC reported). As EFED's determination for risk to listed plant species is based on the most sensitive apical endpoint (*i.e.*, the NOAEC for soybean plant height from the available vegetative vigor study with dicamba DGA, 0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), less sensitive endpoints reported in the literature for effects to progeny would not impact EPA's risk assessments. EFED's policy regarding open literature is that typically if endpoints from the open literature are not more sensitive than guideline endpoints, then further analysis is not required (USEPA, 2011b)

5. Revised Terrestrial Vertebrate Endpoints

Parent Dicamba

The risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016, D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. The revised T-REX run presented in **Section 6** of this addendum reflects the adjusted chronic endpoint for parent dicamba.

Metabolite DCSA

Following preliminary review of a rat 2-generation study with DCSA (MRID 47899517), the risk assessment for the proposed new use on soybeans (USEPA, 2011 D378444) used a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016) was completed to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016) determined BMD₅ (estimated benchmark dose [BMD] to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised T-REX analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

6. Revised T-REX Analysis for Parent Dicamba and Quantitative Assessment of DCSA Exposure and Risk

Dicamba-specific Half-Life

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. However, EFED has refined this analysis by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application); a chemical-specific foliar dissipation half-life value for parent dicamba

(described below); and the new chronic mammalian endpoint for parent dicamba (described previously in **Section 5**).

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 2**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 2. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Parent Dicamba T-REX Analysis

Modeled maximum residue values (EECs) determined using this refined approach were slightly higher (~15%) than those determined in the original dicamba-tolerant soybean Section 3 assessment, but would not have impacted the screening-level risk conclusions for any assessed taxa. The previous risk assessment (2011) concluded that there was potential for direct adverse effects to mammals from chronic exposures of dicamba (max chronic RQ was 2.31 for small mammals consuming short grass). Following the refinements presented in this section (3 applications of dicamba to include the two post-emergent applications at the 0.5 lb a.e./A rate, foliar dissipation half-life decreased from 35 days to 8.4 days, and an increase in the mammalian chronic endpoint from 45 mg/kg-bw to 136 mg/kg-bw), there are no longer any exceedances for any size class of mammal consuming any dietary item (max RQ = 0.84, see **Appendix 1** for full T-REX input and output)

DCSA Metabolite Exposure Analysis

Since the chronic toxicity endpoints are more sensitive for DCSA than dicamba and DCSA residues were higher than dicamba residues within dicamba-tolerant soybean plant tissues (see below), EFED separately assessed the chronic exposure to DCSA residues for birds and mammals.

The available data indicate that DCSA has similar acute toxicity as parent dicamba, but is substantially more toxic on a chronic basis to mammals. In conventional soybean plants, DCSA residues following dicamba applications prior to planting were less than 2% of total dicamba residues in forage, hay and seed (MRIDs 43814101 and 44089307; max of 0.130 ppm DCSA, see **Appendix 2**) and would not be above toxicity thresholds for any taxa. However, in dicamba-tolerant soybean plants, dicamba is converted to DCSA and its glycosidic conjugates following demethylation of the aromatic methoxy moiety of dicamba (USEPA, 2013. HED residue chemistry summary) and in comparison to dicamba use on conventional soybeans, the maximum residues of DCSA in dicamba-tolerant soybean field trials following one 1-lb/A pre-emergent application and two 0.5-lb/A post-emergent applications were a substantially higher proportion of dicamba-related residues in forage, hay and seed (**Appendix 2** and MRID 47899524; 76%--88% of total dicamba-related residues). The empirical data from MRID 47899524 found means and maximums, respectively, of DCSA concentrations of 17.0 and 51.3 ppm, in forage 7-10 days following the last application, 32.2 and 61.1 ppm in hay 13-15 days following the last application and 0.059 and 0.440 ppm in seeds 73-98 days after the last application. EFED used the maximum measured values from the empirical data on forage, hay and seeds to assess risk to terrestrial vertebrates. There is some uncertainty in this approach as the maximum DCSA residues appear to be slightly increasing (16%) between forage at 7-10 days and hay at 13-15 days, however this could be due to the difference between fresher forage and drier hay, where DCSA has become more concentrated compared to the overall plant biomass, rather than due to additional conversion of dicamba residues to DCSA. Additionally, the amount of additional dicamba available to potentially convert to DCSA appears limited after this point as the maximum residues of dicamba were only 2.62 and 1.16 ppm in forage and hay, respectively.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-soybean and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization. This is because the conversion of dicamba to DCSA in plants is only expected to occur in crops modified to be tolerant to dicamba.

DCSA Effects Assessment

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds, resulting in a chronic avian endpoint of 40.9 mg/kg-bw. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who would not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into the egg during egg development).

Using the empirical dataset for DCSA residues in DT-soybean crops (as described above), the maximum residues in soybean forage and hay tissue were 61.1 ppm and in seeds were 0.440 ppm. Residues in arthropods (as a dietary item for birds and mammals consuming insects that

have consumed soybean tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications and therefore were considered to contain 42.5 ppm. This is likely conservative, given that the residues from the nomogram are for external residues in food items following a spray application while the actual exposures would be internal residue concentrations in the plant. A screening assessment using this empirical data for the exposure values results in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay tissue or consuming insects that had consumed soybean tissues with DCSA residues (RQs range from **1.1—3.3**, **Table 3**), for small birds consuming forage and hay tissue or insects that had fed on DT-soybean tissues, (RQs range from **1.2—1.7**, **Table 4**) and medium birds feeding on forage/hay tissue (marginal exceedance of **1.0**) but no exceedances occurred for any size mammalian or avian granivore consuming soybean grain (max granivore RQ of < 0.01).

Table 3. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-soybean tissues containing DCSA residues (maximum 61.1 mg/kg in forage/hay, 0.44 mg/kg in seeds) or consuming arthropods that had fed on DT-soybean tissues (assumed to contain 42.5 mg/kg DCSA). Bold RQ values exceed the LOC.

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Forage/Hay	0.0143	58.25	6.2	3.3
	Seed	0.00318	0.09	6.2	<0.01
	Arthropod	0.0143	40.52	6.2	2.3
Medium (35g)	Forage/Hay	0.0231	40.33	14.2	2.8
	Seed	0.00513	0.06	14.2	<0.01
	Arthropod	0.0231	28.05	14.2	2.0
Large (1000g)	Forage/Hay	0.153	9.35	17.6	1.5
	Seed	0.0340	0.01	17.6	<0.01
	Arthropod	0.153	6.50	17.6	1.1

Table 4. Dose-based exposure and risk quotients for birds consuming DT-soybean tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA for birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Forage/Hay	0.0228	69.65	40.9	1.7
	Seed	0.0051	0.11	40.9	<0.01
	Arthropod	0.0228	48.45	40.9	1.2
Medium (100g)	Forage/Hay	0.0649	39.65	40.9	1.0
	Seed	0.0144	0.06	40.9	<0.01
	Arthropod	0.0649	27.58	40.9	0.7
Large (1000g)	Forage/Hay	0.291	17.78	40.9	0.4
	Seed	0.065	0.03	40.9	<0.01
	Arthropod	0.291	12.37	40.9	0.3

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-soybean tissues (forage from days 7-10, hay from days 13-15 and seeds from

days 73-98) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-soybean plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure.

As noted above, EFED calculated these RQs based on the female lactation dose NOAEL endpoint of 8 mg/kg/d from the DCSA 2-generation study where reductions of up to 9% pup body weight were observed 2-3 weeks post birth at the next highest dose (78 mg/kg/d). If the BMDL₅ (the lower 95% confidence level on the estimated benchmark dose to result in a 5% body weight change in pups from background levels) of 34.9 mg/kg/d calculated by HED (EPA, 2016) for DCSA was used in place of the NOAEL, then the maximum residues from the empirical data in soybean hay would be below the threshold dose for all size classes of mammals feeding on soybean plant tissue or soybean-consuming arthropods (RQs would range from 0.35—0.76 for mammals feeding on tolerant soybean tissues and 0.24—0.53 for mammals feeding on arthropods having consumed soybean tissues).

7. Terrestrial Invertebrates Risk Characterization

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum¹ establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This addendum document explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial

¹ <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact $LD_{50} > 91 \mu\text{g a.e./bee}$ (MRID 00036935). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LD_{50} (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate ($1.0 \text{ lbs a.e./A} \times 2.7 \mu\text{g a.e./bee}$ (upper bound for contact exposures from a direct spray of 1 lb a.e./A , based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 ($2.7/91$) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral $LC_{50} > 100 \mu\text{g a.e./bee}$). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC_{50} (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of $32.12 \mu\text{g/bee/bee/day}$ ($1.0 \text{ lb a.e./A} \times 110 \mu\text{g a.e./g}$ {upper-bound residue for tall grass from T-REX} $\times 0.292 \text{ g/day}$ {pollen consumption rate}), the resultant RQ would be 0.32 ($32.12/100$) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may

² The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured. Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the soybean risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ³	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁴

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

³ Test material was dicamba BAPMA salt

⁴ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated contact-based bee chronic NOAEC of 38 µg a.e./bee. The acute dietary estimated exposure level for adult honeybees is 32.12 µg/bee/day for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 µg a.e./bee. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (*e.g.*, an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary

exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate developmental life stages and survival in organisms following prolonged exposure); and
2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the soybean risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning in summer, 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC_{50} of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-soybean plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

8. *Runoff*

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). According to the original ecological risk assessment (USEPA, 2011a), dicamba is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 3** for calculations). Using these assumptions in TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 3**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

9. *Herbicide Interactions (Synergism)*

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba

and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent application (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans

Chemical Identity and Application Information				Application No.	Rate	Day of Application
Chemical Name:	Dicamba			1	1	0
Seed Treatment? (Check if yes)	<input type="checkbox"/>			2	0.5	7
Use:	cropcare			3	0.5	14
Product name and form:				4		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%			5		
Half-life (days):	8.4			6		
Are you assessing applications with variable rates or intervals?	yes			7		
Assessed Species Inputs (optional, use defaults for RQs for national level assessments)				8		
What body weight range is assessed (grams)?	Birds	Mammals		9		
Small	20	15		10		
Medium	100	35		11		
Large	1000	1000		12		
Reset Model				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		
				21		
				22		
				23		
				24		
				25		
				26		
				27		
				28		
				29		
				30		

The value in G6 must be zero

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	
LD50 (mg/kg-bw)	188.00	Subacute oral	
LC50 (mg/kg-diet)	10000.00	Subacute oral	
NOAEL (mg/kg-bw)		Subacute oral	
NOAEC (mg/kg-diet)	695.00	Mixed oral	
Enter the Mineau et al. Scaling Factor		1.15	
Mammalian			
Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			Reference (MRID)
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose	2720	mg/kg-diet based on standard FDA lab rat conversion	

Optional Test Organism Body weight (g)	Optional Test Species Name	Toxicity Value Reference (MRID)

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.87	4.16	0.03
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.39	2.37	0.01
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.12	1.06	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients

NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.0163	3.4819	0.0006
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.0139	2.4065	0.0005
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.0075	0.5579	0.0003

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.33	3.48	0.01
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.28	2.41	0.01
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.15	0.56	0.01

Appendix 2. Dicamba Crop Field Trial Residue Data Which Include the Determination of the DCSA Metabolite.

Table 1. Summary of Residues from Conventional Asparagus Crop Field Trials with DCSA as a Dicamba Residue of Concern.¹

Formulation ²	Total Application Rate (lb ae/A)	PHI (days)	N ³	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁵	HAFT ⁵	Median ⁵	Mean ⁵	SD ⁵
4 lb ae/gal DGA SL, 4 lb ae/gal DGA SL, and 2 lb ae/gal Na SL	Single post-emergence broadcast application of 0.5 lb ae/A	1	24	Parent	0.266	3.274	0.304	3.144	0.604	0.967	0.852
				DCSA ⁴	<0.01	0.071	<0.01	<0.040	0.011	0.014	0.0069
				Total	0.271	3.192	0.314	3.166	0.622	0.981	0.854

¹ Asparagus data are taken directly from MRID Nos. 43245206 and 43425803 (D204488, D204809, and D209229, L. Cheng, 07/14/1997) used for tolerance re-assessment in the 2005 RED.

² Test applications included the dimethylamine (DMA), diglycolamine (DGA), and sodium (Na⁺) salt formulations.

³ number of samples.

⁴ DCSA is the 3,6-dichloro-2-hydroxybenzoic acid metabolite.

⁵ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 2. Summary of Residues from Conventional Soybean Crop Field Trials (Seed) with DCSA as a Dicamba Residue of Concern.^{1,2}

Formulation ³	Total Application Rate (lb ae/A)	PHI (days)	N ⁴	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁶	HAFT ⁶	Median ⁶	Mean ⁶	SD ⁶
4 lb ae/gal DMA SL	Single 0.5 lb ae pre-plant treatment followed by a single post-emergence application of 2.0 lb ae/A	7	24	Parent	0.027	8.10	0.038	7.40	0.72	1.022	1.703
				DCSA ⁵	<0.01	0.130	<0.01	<0.048	.014	0.02	0.015
				5-OH dicamba	<0.01	0.360	<0.01	0.26	0.01	0.043	0.071
				Total	0.047	8.14	0.084	7.44	0.768	1.085	1.713

¹ Soybean grain data are for the 1X rate which used a 0.5 lb ae/A treatment made at 14-days pre-planting followed by a 2.0 lb ae/A treatment made at 7-days prior to harvest taken directly from MRID Nos. 43814101 (D223283, S. Knizner, 07/29/1996) and 44089307 (D228703, S. Chun, 07/16/1998) used for tolerance reassessment in the 2005 RED.

² The registrant was not supporting tolerances for soybean forage and hay at this time in lieu of a feeding restriction placed on the label. However, data were included for these commodities in the study submissions acquired using a single 0.5 lb ae/A treatment made at 14-days pre-planting (0.25x the maximum rate). Total residues of dicamba (parent, DCSA, and 5-OH dicamba) were <0.03 - <0.097 ppm in soybean forage and <0.03 - <0.04 ppm in soybean hay.

³ Test applications included the dimethylamine (DMA) salt formulation.

⁴ number of samples.

⁵ DCSA is the 3,6-dichloro-5-hydroxybenzoic acid metabolite.

⁶ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 3. Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

¹ Except for sample min/max, values reflect per trial averages; n = no. of field trials. For calculation of median, mean, and standard deviation, the LOQ (0.02 ppm each analyte in undelinted cotton seed and 0.04 ppm for each analyte in cotton gin byproducts) was used for any results reported as <LOQ in Table C.3. Combined residues of dicamba, 5-OH dicamba, DCSA, and DCSA are expressed in parent equivalents. Individual analyte results are reported as per se. N/A = Not applicable.

² LAFT = lowest-average-field-trial; HAFT = highest-average-field-trial.

Table 4. Summary of Residues from Dicamba-Tolerant Soybean Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Total Applic. Rate lb a.e./A (kg a.e./ha)	PHI (days)	Residue Levels ^{a, b} (ppm)						
			N	Min.	Max.	HAFT	Median (STMdR)	Mean (STMR)	Std. Dev.
DCGA ^c									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	0.356	5.90	5.27	1.93	2.02	1.02
Hay		13-15	44	0.167	7.26	7.19	2.00	2.66	1.91
Seed		73-98	44	<0.011	0.135	0.131	0.017	0.032	0.029
DCSA									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	8.92	51.3	50.4	15.0	17.0	8.00
Hay		13-15	44	12.2	61.1	60.7	31.9	32.2	11.2
Seed		73-98	44	0.010	0.440	0.439	0.033	0.059	0.089
Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	2.62	2.47	0.068	0.374	0.603
Hay		13-15	44	<LOQ	1.16	1.01	0.051	0.130	0.216
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
5-OH Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	0.009	0.009	0.005	0.006	<LOQ
Hay		13-15	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

^aConcentrations of the individual analytes are reported as dicamba equivalents

^bValues < LOQ are assumed to be at the LOQ.

^c DCGA residues were quantitated by a non-validated method

Appendix 3: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in **Table 1** for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure 1**. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in **Tables 2** and **3**.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%). In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40	105

°Lat	
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

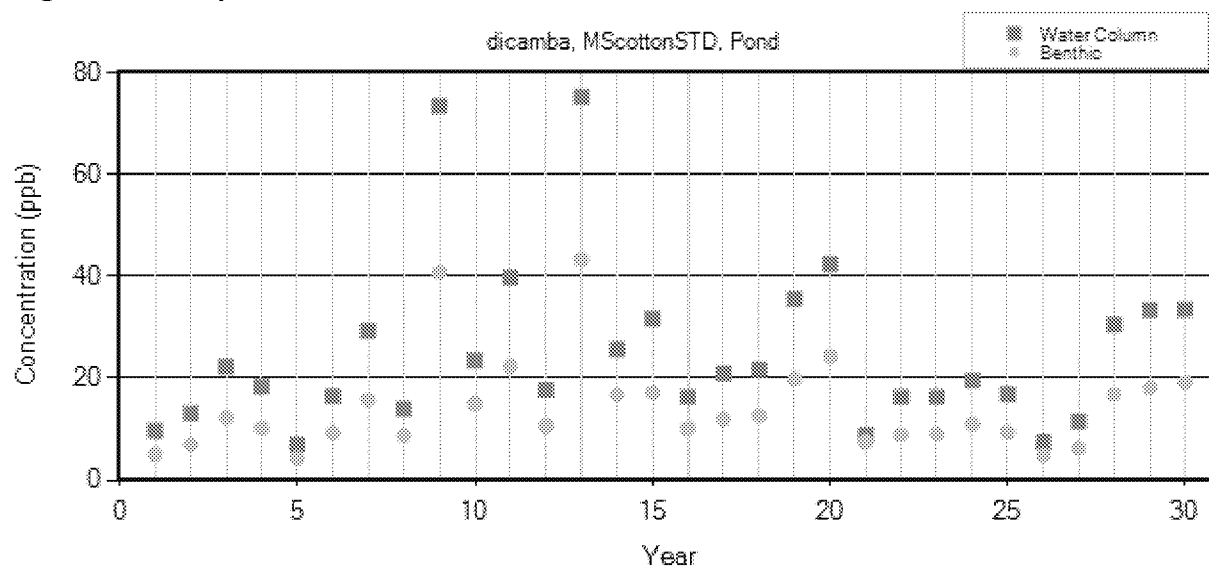


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (102,790 \text{ L water/ Acre-in}) * (1 \text{ inch}) * (1 \text{ lb/ } 453,592 \text{ mg})$
which reduces to:

Equation 2.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (0.226613)$

$EEC \text{ lb ai/A} = 0.061 \text{ mg/L} * 0.226613 = 0.0138$

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be $EEC \text{ lb ae/A} = 0.005 \text{ mg/L} * 0.226613 = 0.0011$. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e./A application rate and 0.06% loss through runoff and erosion.

Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (ERIM) 3-8-11
Michael Wagman 3/8/11

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

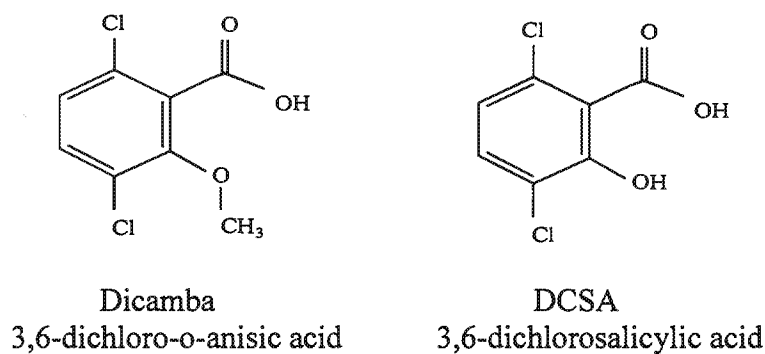
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		

¹- M1691 Herbicide

²- Registered uses

³- "Acid equivalent"

⁴- Calculated by dividing the max application rate by the max individual application rate.

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

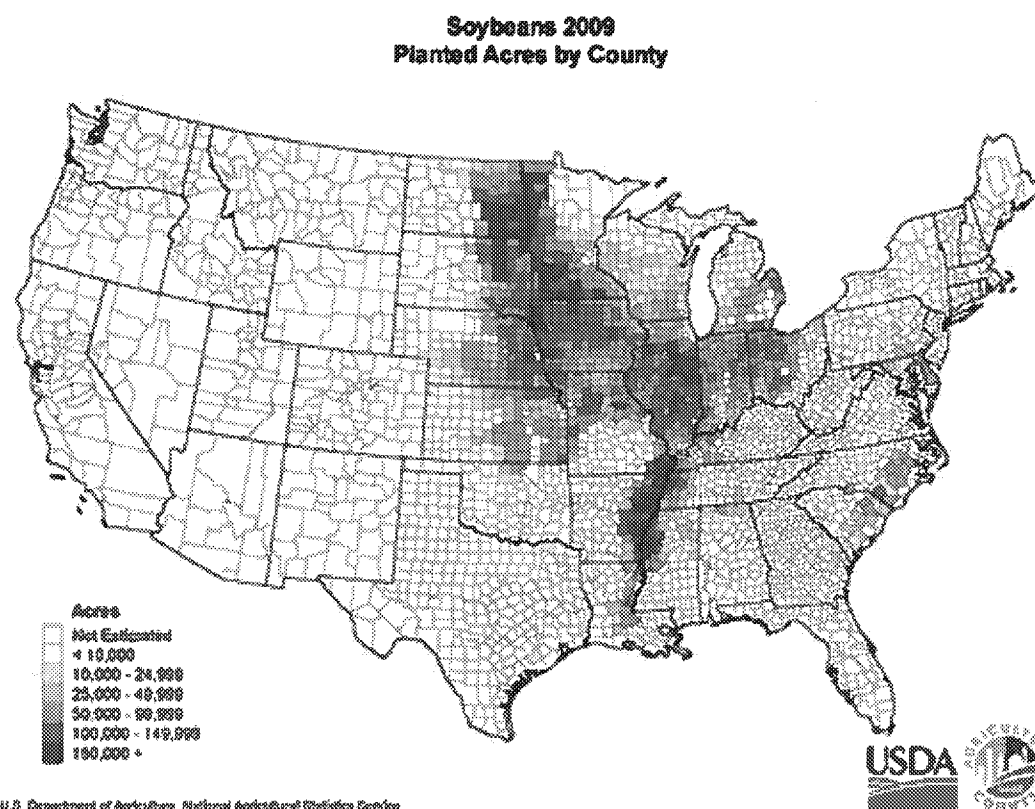


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute - listed; chronic - listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

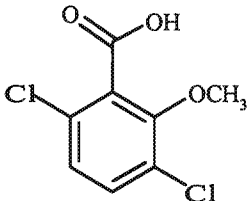
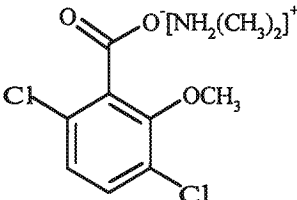
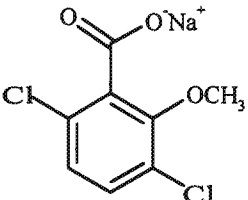
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
-------------	---------------	-------	-------	----------

Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/30/2016 7:36:35 PM
To: Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
Subject: RE: Can you send me the EFED RA for dicamba - whichever one has the fate discussion, probably the original one
Attachments: Section 3 new use (cotton).pdf; Section 3 new use (soybean).pdf; Section 3 new use (soybean) addendum #2.pdf; Section 3 new use (soybean) addendum #1.pdf

*Grant Rowland
Herbicide Branch
Registration Division
Office of Pesticide Programs
703-347-0254*

From: Montague, Kathryn V.
Sent: Wednesday, March 30, 2016 3:32 PM
To: Rowland, Grant <Rowland.Grant@epa.gov>
Subject: Can you send me the EFED RA for dicamba - whichever one has the fate discussion, probably the original one

Thanks!



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *EW* 3/24/16
Elizabeth Donovan, Biologist *ED* 3/24/16
William P. Eckel, Ph.D., Senior Science Advisor *WPE* (For BE) 3-24-16
Amy Blankinship, Senior Science Advisor *AB*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II® XTENDFLEX™ cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

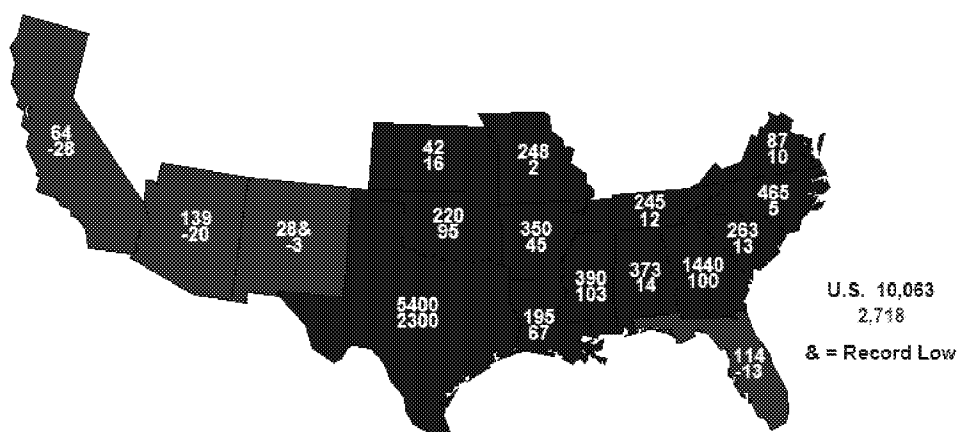
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3** and **4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _∞ (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and **bold italicized** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
Medium (35g)	Arthropod	0.0143	4.19	17.58	0.24
	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
Large (1000g)	Arthropod	0.0231	2.90	14.23	0.20
	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 ($>100/42 = >2.38$).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-course droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TT111004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, than given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	Seeding Rate (lbs/acre)	18.9
Seed Treatment? (Check if yes)	<input type="checkbox"/>		
Use:	cotton, all or unspecified		
Product name and form:			
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%		
Half-life (days):	8.4		
Are you assessing applications with variable rates or intervals?	yes		

For HETI specify application day at Column F and % of day for up to 30 applications

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	Optional Test Species Name
Mammalian			
Size (g) of mammal used in toxicity study		Acute Study	Chronic Study
Default rat body weight is 350 grams		350	350
Endpoint	Toxicity value	Reference (MRID)	
LD50 (mg/kg-bw)	2740.00		
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

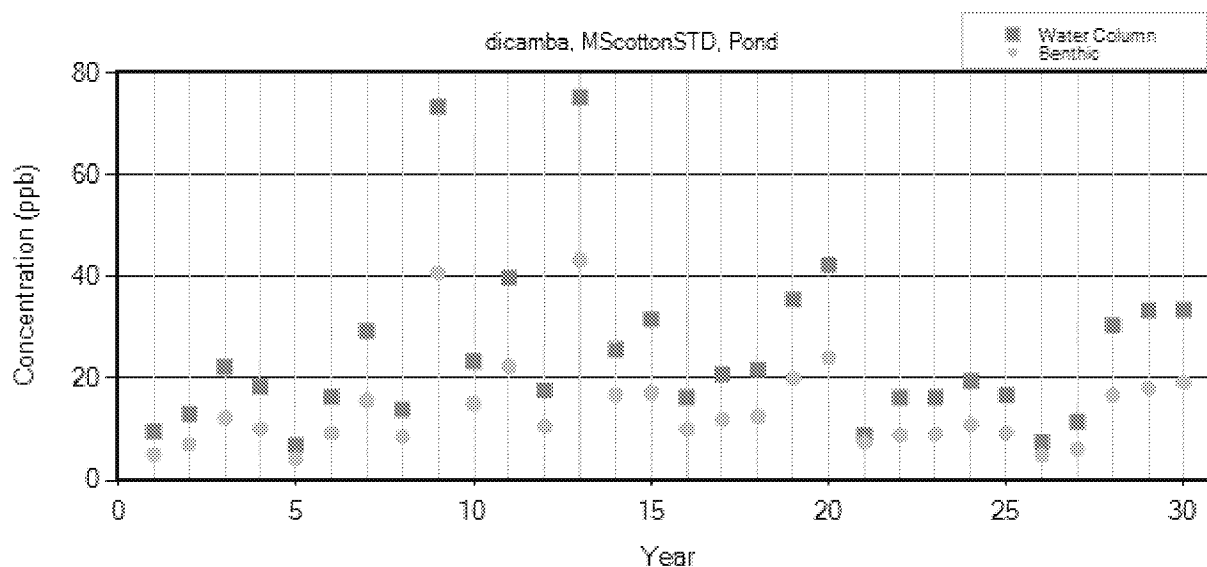


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

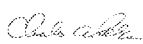
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

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Date: 2014.05.20 08:29:33 -04'00'
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email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
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REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be $0.1833 \text{ g}/\text{s}$)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = $1,200 \text{ g}/\text{m}^3$

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than $0.0005 \text{ lb a.i.}/\text{A}$) the air concentration (C_{yv}) would have to be greater than $721 \mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of $0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 ug/m³ less than the air concentration required to exceed the EC₂₅ (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 µg/m²•s⁻¹, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 ug/m³ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC₂₅). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC₂₅ at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean

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This is an addendum to the Environmental Fate and Effects Division's (EFED) ecological risk assessment for dicamba DGA salt (Clarity[®] formulation or M169I, EPA Reg No. 524-582) and its degradate, 3,6-dichlorosalicylic acid (DCSA), for the proposed new use on dicamba-tolerant soybean. It includes analysis of information that was not previously included in the original soybean new use risk assessment (USEPA, 2011, DP 378444). Since the original risk assessment was conducted, the registrant, Monsanto, has submitted:

- 1) field trial data that impacts EFED's previous analysis of spray drift,
- 2) data for incidents and inquiries from the use of dicamba DGA salt,

- 3) laboratory volatility data for dicamba DGA and DMA salt formulations, and
- 4) terrestrial plant reproductive effects data.

Additionally, this addendum includes analysis conducted by EFED regarding:

- 5) the implication of new mammalian chronic effects endpoints for parent dicamba and the metabolite DCSA from the Health Effects Division (HED; USEPA 2016, D378366+),
- 6) a revised T-REX run using refined estimates of foliar dissipation half-lives and variable application rates,
- 7) the potential for effects to beneficial terrestrial invertebrates,
- 8) effects posed by runoff, and
- 9) potential synergistic interactions with glyphosate.

1. Spray Drift and Buffers (Field Trial Data)

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that the distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate). However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect

distance for sensitive plants (the “no-effect” distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto’s statement that the field trial data are not suitable for use in EPA’s regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical

endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED's Process to Determine a "No Effect" Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered "controls," though there are considerable uncertainties to this approach. Specifically, no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these "controls" the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the "control" means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a "no effect" distance at each site was considered the first distance greater than the maximum distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the "no effect" distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.e./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 1. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than only 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Weight of Evidence Conclusions

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of this field trial data is not suitable for the purpose of establishing an appropriate buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.e./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTII 1004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate and with the described nozzles restricting the droplet spectra extra-coarse and ultra-coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

2. Incidents

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in

place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (e.g. burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (e.g. leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EIIIS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. The air temperature and humidity at the time of dicamba application were reported to be 82°F and 55%, respectively. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8

µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements, as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty whether this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing. Further discussion of volatility is provided in **Section 3** below.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where "dicamba type" damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto's submitted information on the 73 incidents from 2012-2014 (discussed previously in this section). With the current information available, and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri). The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made.

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that were not followed included tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EHS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants, and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize since the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more likely impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory data conditions. Additional discussion and characterization of volatility is provided in the next section.

3. Volatility

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, because these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 lb a.e./A application rate and 220 feet for the 1.0 lb a.e./A application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However, consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the previous section (MO Case File #81513M00701, EHS Incident report number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (e.g. cooler temperatures)

4. Potential Effects on Terrestrial Plant Reproduction

EFED is aware of published literature associating dicamba applications with effects to soybean progeny. These studies indicate potential effects to the quantity and reproductive quality of future soybean generations following dicamba applications that would not be observed in the guideline vegetative vigor and seedling emergence studies EFED typically uses to assess risk to terrestrial plants. Therefore, these data raise a potential concern that has not been directly addressed in OPP assessments, should these effects occur at lower exposures than the effects observed in the guideline terrestrial plant studies. In meetings and email correspondence in January/February, 2015, OPP asked whether Monsanto was aware of this issue. Monsanto requested the references that OPP was aware of, so that they could independently review them.

Monsanto reviewed the open literature references provided by OPP and stated that none of the studies described effects on progeny at application rates lower than OPP's lowest available regulatory endpoint from the available vegetative vigor plant study (0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), therefore any mitigations (*i.e.* spray drift buffers) based on the plant height endpoint would be protective for effects to progeny.

The open literature studies examined seeds/pod, seed weight, seed quality, delayed maturation, pod malformation, reduced germination or progeny emergence, and malformed progeny. The vast majority of the studies did not investigate effects at rates as low as the NOAEC from the available vegetative vigor study. Monsanto's review of the available information indicated that the lowest effects endpoint reported from these studies was for delayed maturation of soybeans at rates as low as 0.56 g a.e./A from Kelley *et al.* (2005), which would still be almost 2 times less sensitive than the regulatory endpoint based on plant height that EFED has used in its risk assessments. Monsanto concluded that the open literature studies did not contain information that indicated that the in-field buffer based on plant height that is on the draft label would not also be protective of these reproductive effects.

EFED acknowledges Monsanto's submission of their analysis of the open literature data for effects to progeny, but to date has not independently reviewed each of these studies. However, for the following reason, EFED does not believe the information would change its risk assessments. The most sensitive endpoint reported in the open literature was a LOAEC of 0.56 g a.e./A for delayed maturation of soybeans (Kelley *et al.*, 2005; no NOAEC reported). As EFED's determination for risk to listed plant species is based on the most sensitive apical endpoint (*i.e.*, the NOAEC for soybean plant height from the available vegetative vigor study with dicamba DGA, 0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), less sensitive endpoints reported in the literature for effects to progeny would not impact EPA's risk assessments. EFED's policy regarding open literature is that typically if endpoints from the open literature are not more sensitive than guideline endpoints, than further analysis is not required (USEPA, 2011b)

5. Revised Terrestrial Vertebrate Endpoints

Parent Dicamba

The risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016, D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. The revised T-REX run presented in **Section 6** of this addendum reflects the adjusted chronic endpoint for parent dicamba.

Metabolite DCSA

Following preliminary review of a rat 2-generation study with DCSA (MRID 47899517), the risk assessment for the proposed new use on soybeans (USEPA, 2011 D378444) used a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016) was completed to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016) determined BMD₅ (estimated benchmark dose [BMD] to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised T-REX analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

6. Revised T-REX Analysis for Parent Dicamba and Quantitative Assessment of DCSA Exposure and Risk

Dicamba-specific Half-Life

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. However, EFED has refined this analysis by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application); a chemical-specific foliar dissipation half-life value for parent dicamba

(described below); and the new chronic mammalian endpoint for parent dicamba (described previously in **Section 5**).

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 2**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 2. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Parent Dicamba T-REX Analysis

Modeled maximum residue values (EECs) determined using this refined approach were slightly higher (~15%) than those determined in the original dicamba-tolerant soybean Section 3 assessment, but would not have impacted the screening-level risk conclusions for any assessed taxa. The previous risk assessment (2011) concluded that there was potential for direct adverse effects to mammals from chronic exposures of dicamba (max chronic RQ was 2.31 for small mammals consuming short grass). Following the refinements presented in this section (3 applications of dicamba to include the two post-emergent applications at the 0.5 lb a.e./A rate, foliar dissipation half-life decreased from 35 days to 8.4 days, and an increase in the mammalian chronic endpoint from 45 mg/kg-bw to 136 mg/kg-bw), there are no longer any exceedances for any size class of mammal consuming any dietary item (max RQ = 0.84, see **Appendix 1** for full T-REX input and output)

DCSA Metabolite Exposure Analysis

Since the chronic toxicity endpoints are more sensitive for DCSA than dicamba and DCSA residues were higher than dicamba residues within dicamba-tolerant soybean plant tissues (see below), EFED separately assessed the chronic exposure to DCSA residues for birds and mammals.

The available data indicate that DCSA has similar acute toxicity as parent dicamba, but is substantially more toxic on a chronic basis to mammals. In conventional soybean plants, DCSA residues following dicamba applications prior to planting were less than 2% of total dicamba residues in forage, hay and seed (MRIDs 43814101 and 44089307; max of 0.130 ppm DCSA, see **Appendix 2**) and would not be above toxicity thresholds for any taxa. However, in dicamba-tolerant soybean plants, dicamba is converted to DCSA and its glycosidic conjugates following demethylation of the aromatic methoxy moiety of dicamba (USEPA, 2013. HED residue chemistry summary) and in comparison to dicamba use on conventional soybeans, the maximum residues of DCSA in dicamba-tolerant soybean field trials following one 1-lb/A pre-emergent application and two 0.5-lb/A post-emergent applications were a substantially higher proportion of dicamba-related residues in forage, hay and seed (**Appendix 2** and MRID 47899524; 76%--88% of total dicamba-related residues). The empirical data from MRID 47899524 found means and maximums, respectively, of DCSA concentrations of 17.0 and 51.3 ppm, in forage 7-10 days following the last application, 32.2 and 61.1 ppm in hay 13-15 days following the last application and 0.059 and 0.440 ppm in seeds 73-98 days after the last application. EFED used the maximum measured values from the empirical data on forage, hay and seeds to assess risk to terrestrial vertebrates. There is some uncertainty in this approach as the maximum DCSA residues appear to be slightly increasing (16%) between forage at 7-10 days and hay at 13-15 days, however this could be due to the difference between fresher forage and drier hay, where DCSA has become more concentrated compared to the overall plant biomass, rather than due to additional conversion of dicamba residues to DCSA. Additionally, the amount of additional dicamba available to potentially convert to DCSA appears limited after this point as the maximum residues of dicamba were only 2.62 and 1.16 ppm in forage and hay, respectively.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-soybean and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization. This is because the conversion of dicamba to DCSA in plants is only expected to occur in crops modified to be tolerant to dicamba.

DCSA Effects Assessment

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds, resulting in a chronic avian endpoint of 40.9 mg/kg-bw. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who would not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into the egg during egg development).

Using the empirical dataset for DCSA residues in DT-soybean crops (as described above), the maximum residues in soybean forage and hay tissue were 61.1 ppm and in seeds were 0.440 ppm. Residues in arthropods (as a dietary item for birds and mammals consuming insects that

have consumed soybean tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications and therefore were considered to contain 42.5 ppm. This is likely conservative, given that the residues from the nomogram are for external residues in food items following a spray application while the actual exposures would be internal residue concentrations in the plant. A screening assessment using this empirical data for the exposure values results in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay tissue or consuming insects that had consumed soybean tissues with DCSA residues (RQs range from **1.1—3.3**, **Table 3**), for small birds consuming forage and hay tissue or insects that had fed on DT-soybean tissues, (RQs range from **1.2—1.7**, **Table 4**) and medium birds feeding on forage/hay tissue (marginal exceedance of **1.0**) but no exceedances occurred for any size mammalian or avian granivore consuming soybean grain (max granivore RQ of < 0.01).

Table 3. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-soybean tissues containing DCSA residues (maximum 61.1 mg/kg in forage/hay, 0.44 mg/kg in seeds) or consuming arthropods that had fed on DT-soybean tissues (assumed to contain 42.5 mg/kg DCSA). Bold RQ values exceed the LOC.

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Forage/Hay	0.0143	58.25	6.2	3.3
	Seed	0.00318	0.09	6.2	<0.01
	Arthropod	0.0143	40.52	6.2	2.3
Medium (35g)	Forage/Hay	0.0231	40.33	14.2	2.8
	Seed	0.00513	0.06	14.2	<0.01
	Arthropod	0.0231	28.05	14.2	2.0
Large (1000g)	Forage/Hay	0.153	9.35	17.6	1.5
	Seed	0.0340	0.01	17.6	<0.01
	Arthropod	0.153	6.50	17.6	1.1

Table 4. Dose-based exposure and risk quotients for birds consuming DT-soybean tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA for birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Forage/Hay	0.0228	69.65	40.9	1.7
	Seed	0.0051	0.11	40.9	<0.01
	Arthropod	0.0228	48.45	40.9	1.2
Medium (100g)	Forage/Hay	0.0649	39.65	40.9	1.0
	Seed	0.0144	0.06	40.9	<0.01
	Arthropod	0.0649	27.58	40.9	0.7
Large (1000g)	Forage/Hay	0.291	17.78	40.9	0.4
	Seed	0.065	0.03	40.9	<0.01
	Arthropod	0.291	12.37	40.9	0.3

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-soybean tissues (forage from days 7-10, hay from days 13-15 and seeds from

days 73-98) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-soybean plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure.

As noted above, EFED calculated these RQs based on the female lactation dose NOAEL endpoint of 8 mg/kg/d from the DCSA 2-generation study where reductions of up to 9% pup body weight were observed 2-3 weeks post birth at the next highest dose (78 mg/kg/d). If the BMDL₅ (the lower 95% confidence level on the estimated benchmark dose to result in a 5% body weight change in pups from background levels) of 34.9 mg/kg/d calculated by HED (EPA, 2016) for DCSA was used in place of the NOAEL, then the maximum residues from the empirical data in soybean hay would be below the threshold dose for all size classes of mammals feeding on soybean plant tissue or soybean-consuming arthropods (RQs would range from 0.35—0.76 for mammals feeding on tolerant soybean tissues and 0.24—0.53 for mammals feeding on arthropods having consumed soybean tissues).

7. Terrestrial Invertebrates Risk Characterization

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum¹ establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This addendum document explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial

¹ <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact $LD_{50} > 91 \mu\text{g a.e./bee}$ (MRID 00036935). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LD_{50} (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate ($1.0 \text{ lbs a.e./A} \times 2.7 \mu\text{g a.e./bee}$ (upper bound for contact exposures from a direct spray of 1 lb a.e./A , based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 ($2.7/91$) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral $LC_{50} > 100 \mu\text{g a.e./bee}$). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC_{50} (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of $32.12 \mu\text{g/bee/bee/day}$ ($1.0 \text{ lb a.e./A} \times 110 \mu\text{g a.e./g}$ {upper-bound residue for tall grass from T-REX} $\times 0.292 \text{ g/day}$ {pollen consumption rate}), the resultant RQ would be 0.32 ($32.12/100$) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may

² The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured. Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the soybean risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ³	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁴

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

³ Test material was dicamba BAPMA salt

⁴ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated contact-based bee chronic NOAEC of 38 µg a.e./bee. The acute dietary estimated exposure level for adult honeybees is 32.12 µg/bee/day for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 µg a.e./bee. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (*e.g.*, an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary

exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate developmental life stages and survival in organisms following prolonged exposure); and
2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the soybean risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning in summer, 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC_{50} of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-soybean plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

8. *Runoff*

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). According to the original ecological risk assessment (USEPA, 2011a), dicamba is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 3** for calculations). Using these assumptions in TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 3**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

9. *Herbicide Interactions (Synergism)*

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba

and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent application (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans

Chemical Identity and Application Information

Chemical Name: Dicamba

Seed Treatment? (Check if yes) ☐

Use:

Product name and form:

% A.I. (leading zero must be entered for formulations <1% a.i.):

Half-life (days):

Are you assessing applications with variable rates or intervals? ☒

Seeding Rate (lbs/acre) 166.7

Reset Model

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
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18		
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23		
24		
25		
26		
27		
28		
29		
30		

The value in G6 must be zero

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian

Endpoint	Toxicity value	Indicate test species below
LD50 (mg/kg-bw)	188.00	<input type="text" value="Subacute oral"/>
LC50 (mg/kg-diet)	10000.00	<input type="text" value="Subacute oral"/>
NOAEL (mg/kg-bw)		<input type="text" value="Subacute oral"/>
NOAEC (mg/kg-diet)	695.00	<input type="text" value="Mixed oral"/>

Optional Test Organism Body weight (g)

Optional Test Species Name

Toxicity Value Reference (MRID)

Mammalian

Enter the Mineau et al. Scaling Factor 1.15

Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			Reference (MRID)
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		

Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose

2720

mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.87	4.16	0.03
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.39	2.37	0.01
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.12	1.06	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients

NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.0163	3.4819	0.0006
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.0139	2.4065	0.0005
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.0075	0.5579	0.0003

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.33	3.48	0.01
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.28	2.41	0.01
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.15	0.56	0.01

Appendix 2. Dicamba Crop Field Trial Residue Data Which Include the Determination of the DCSA Metabolite.

Table 1. Summary of Residues from Conventional Asparagus Crop Field Trials with DCSA as a Dicamba Residue of Concern.¹

Formulation ²	Total Application Rate (lb ae/A)	PHI (days)	N ³	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁵	HAFT ⁵	Median ⁵	Mean ⁵	SD ⁵
4 lb ae/gal DGA SL, 4 lb ae/gal DGA SL, and 2 lb ae/gal Na SL	Single post-emergence broadcast application of 0.5 lb ae/A	1	24	Parent	0.266	3.274	0.304	3.144	0.604	0.967	0.852
				DCSA ⁴	<0.01	0.071	<0.01	<0.040	0.011	0.014	0.0069
				Total	0.271	3.192	0.314	3.166	0.622	0.981	0.854

¹ Asparagus data are taken directly from MRID Nos. 43245206 and 43425803 (D204488, D204809, and D209229, L. Cheng, 07/14/1997) used for tolerance re-assessment in the 2005 RED.

² Test applications included the dimethylamine (DMA), diglycolamine (DGA), and sodium (Na⁺) salt formulations.

³ number of samples.

⁴ DCSA is the 3,6-dichloro-2-hydroxybenzoic acid metabolite.

⁵ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 2. Summary of Residues from Conventional Soybean Crop Field Trials (Seed) with DCSA as a Dicamba Residue of Concern.^{1,2}

Formulation ³	Total Application Rate (lb ae/A)	PHI (days)	N ⁴	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁶	HAFT ⁶	Median ⁶	Mean ⁶	SD ⁶
4 lb ae/gal DMA SL	Single 0.5 lb ae pre-plant treatment followed by a single post-emergence application of 2.0 lb ae/A	7	24	Parent	0.027	8.10	0.038	7.40	0.72	1.022	1.703
				DCSA ⁵	<0.01	0.130	<0.01	<0.048	.014	0.02	0.015
				5-OH dicamba	<0.01	0.360	<0.01	0.26	0.01	0.043	0.071
				Total	0.047	8.14	0.084	7.44	0.768	1.085	1.713

¹ Soybean grain data are for the 1X rate which used a 0.5 lb ae/A treatment made at 14-days pre-planting followed by a 2.0 lb ae/A treatment made at 7-days prior to harvest taken directly from MRID Nos. 43814101 (D223283, S. Knizner, 07/29/1996) and 44089307 (D228703, S. Chun, 07/16/1998) used for tolerance reassessment in the 2005 RED.

² The registrant was not supporting tolerances for soybean forage and hay at this time in lieu of a feeding restriction placed on the label. However, data were included for these commodities in the study submissions acquired using a single 0.5 lb ae/A treatment made at 14-days pre-planting (0.25x the maximum rate). Total residues of dicamba (parent, DCSA, and 5-OH dicamba) were <0.03 - <0.097 ppm in soybean forage and <0.03 - <0.04 ppm in soybean hay.

³ Test applications included the dimethylamine (DMA) salt formulation.

⁴ number of samples.

⁵ DCSA is the 3,6-dichloro-5-hydroxybenzoic acid metabolite.

⁶ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 3. Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

¹ Except for sample min/max, values reflect per trial averages; n = no. of field trials. For calculation of median, mean, and standard deviation, the LOQ (0.02 ppm each analyte in undelinted cotton seed and 0.04 ppm for each analyte in cotton gin byproducts) was used for any results reported as <LOQ in Table C.3. Combined residues of dicamba, 5-OH dicamba, DCSA, and DCSA are expressed in parent equivalents. Individual analyte results are reported as per se. N/A = Not applicable.

² LAFT = lowest-average-field-trial; HAFT = highest-average-field-trial.

Table 4. Summary of Residues from Dicamba-Tolerant Soybean Crop Field Trials with DCSA as a Dicamba Residue of Concern.									
Commodity	Total Applic. Rate lb a.e./A (kg a.e./ha)	PHI (days)	Residue Levels ^{a, b} (ppm)						
			N	Min.	Max.	HAFT	Median (STMdR)	Mean (STMR)	Std. Dev.
DCGA ^c									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	0.356	5.90	5.27	1.93	2.02	1.02
Hay		13-15	44	0.167	7.26	7.19	2.00	2.66	1.91
Seed		73-98	44	<0.011	0.135	0.131	0.017	0.032	0.029
DCSA									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	8.92	51.3	50.4	15.0	17.0	8.00
Hay		13-15	44	12.2	61.1	60.7	31.9	32.2	11.2
Seed		73-98	44	0.010	0.440	0.439	0.033	0.059	0.089
Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	2.62	2.47	0.068	0.374	0.603
Hay		13-15	44	<LOQ	1.16	1.01	0.051	0.130	0.216
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
5-OH Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	0.009	0.009	0.005	0.006	<LOQ
Hay		13-15	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

^aConcentrations of the individual analytes are reported as dicamba equivalents

^bValues < LOQ are assumed to be at the LOQ.

^c DCGA residues were quantitated by a non-validated method

Appendix 3: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in **Table 1** for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure 1**. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in **Tables 2** and **3**.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%). In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40	105

°Lat	
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

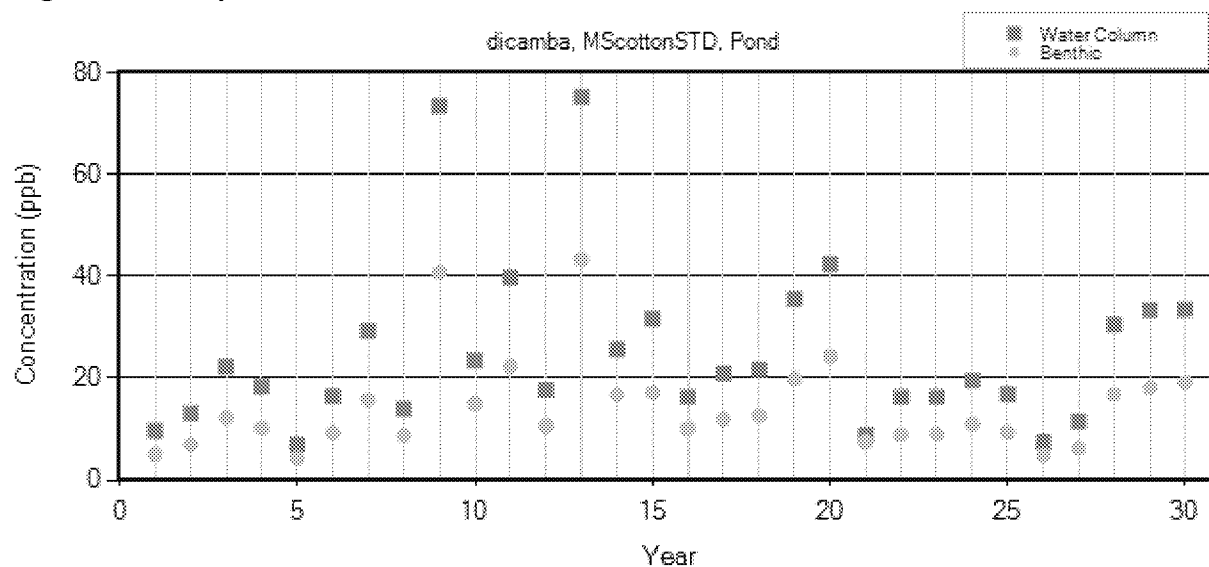


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (102,790 \text{ L water/ Acre-in}) * (1 \text{ inch}) * (1 \text{ lb/ } 453,592 \text{ mg})$
which reduces to:

Equation 2.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (0.226613)$

$EEC \text{ lb ai/A} = 0.061 \text{ mg/L} * 0.226613 = 0.0138$

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be $EEC \text{ lb ae/A} = 0.005 \text{ mg/L} * 0.226613 = 0.0011$. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e./A application rate and 0.06% loss through runoff and erosion.

Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (GrIM) 3-8-11
Michael Wagman 3/8/11

Michael Corbin 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

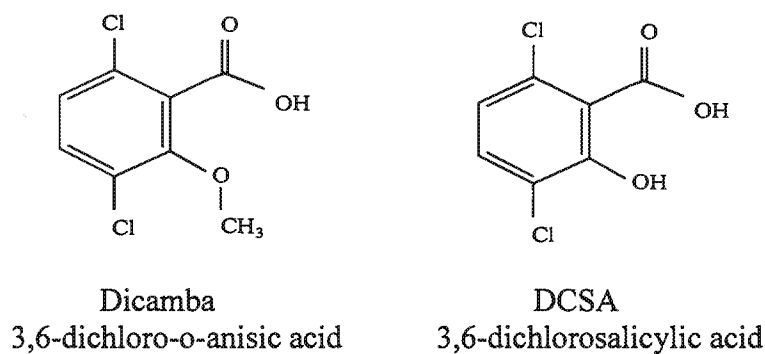
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		
¹ - M1691 Herbicide ² - Registered uses ³ - "Acid equivalent" ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

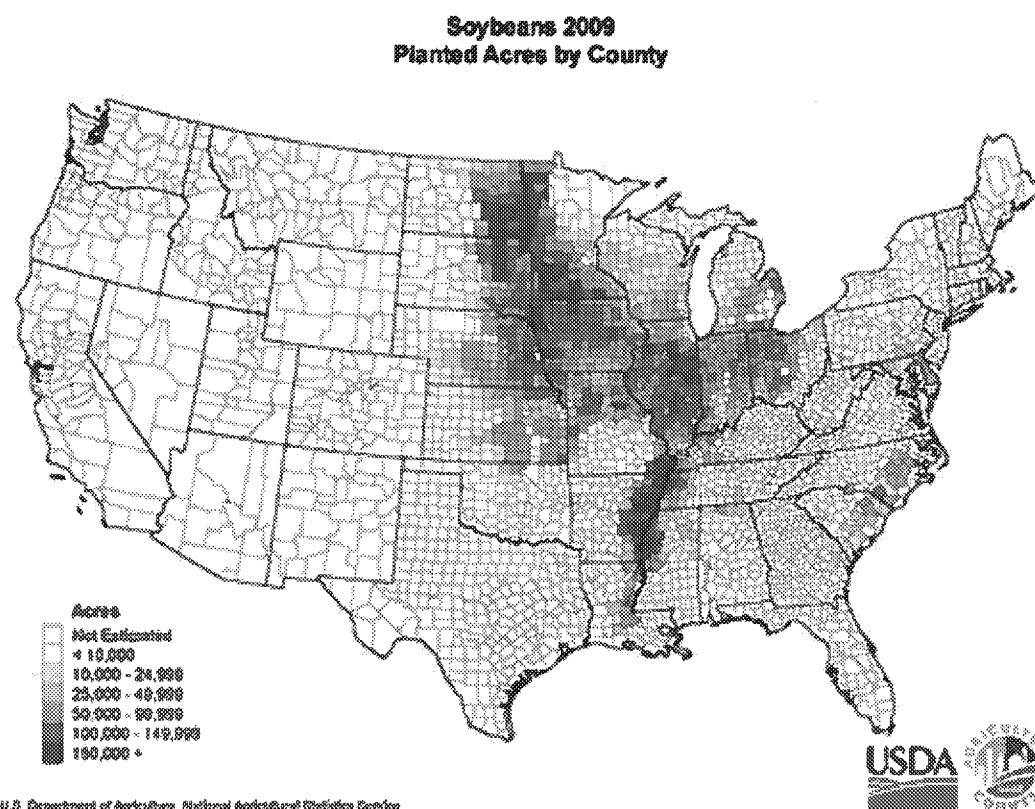


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

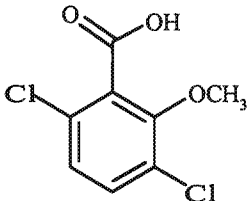
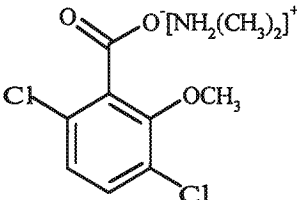
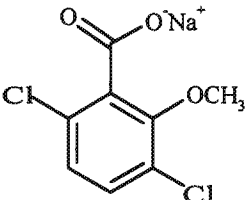
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

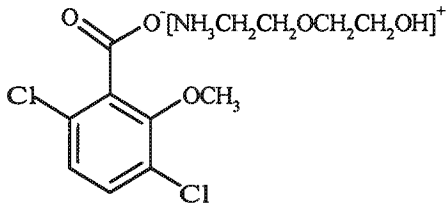
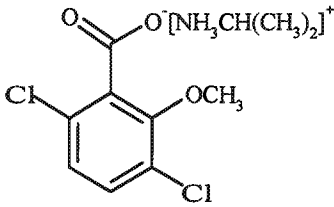
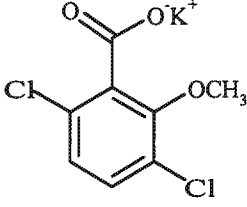
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
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Molecular weight	mw	221	g/mol	
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Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
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Vapor Pressure	vapr	3.41E-5	torr	
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Solubility	sol	6100	mg/L	
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Kd	Kd		mg/L	
----	----	--	------	--

Koc	Koc	13.4	mg/L	
-----	-----	------	------	--

Photolysis half-life	kdp	105	days	Half-life
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Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
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Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
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Aerobic Soil Metabolism	asm	18	days	Halfife
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Hydrolysis:	pH 5	0	days	Half-life
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Hydrolysis:	pH 7	0	days	Half-life
-------------	------	---	------	-----------

Hydrolysis:	pH 9	0	days	Half-life
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Method:	CAM	2	integer	See PRZM manual
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Incorporation Depth:	DEPI		cm	
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Application Rate:	TAPP	1.12	kg/ha	
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Application Efficiency:	APPEFF	0.99	fraction	
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Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
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Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm	
------------------	------	-------	--------------------------------------	--

Interval 1 interval	3	days	Set to 0 or delete line for single app.	
---------------------	---	------	---	--

app. rate 1 apprate	0.56	kg/ha		
---------------------	------	-------	--	--

Interval 2 interval	3	days	Set to 0 or delete line for single app.	
---------------------	---	------	---	--

app. rate 2 apprate	0.56	kg/ha		
---------------------	------	-------	--	--

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run	IR	EPA Pond
-------------------------	----	----------

Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)
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Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214

0.1 2.3788 2.2615 1.958 1.5565 1.3295 0.69082
Average of yearly averages: 0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSSoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Message

From: Adeeb, Shanta [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=DD827C964D6042EB87B3D98B2539BFB9-ADEEB, SHAN]
Sent: 4/4/2016 1:37:00 PM
To: Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
Subject: FW: Dicamba Proposed Decision Final Draft - 3-31-2016.sla.docx
Attachments: Dicamba Proposed Decision Final Draft - 3-31-2016.sla.docx; Dicamba Proposed Reg. Signed. 20160331..pdf

From: Adeeb, Shanta
Sent: Thursday, March 31, 2016 2:46 PM
To: Kenny, Daniel (Kenny.Dan@epa.gov) <Kenny.Dan@epa.gov>; Rowland, Grant (Rowland.Grant@epa.gov) <Rowland.Grant@epa.gov>
Subject: Dicamba Proposed Decision Final Draft - 3-31-2016.sla.docx

Dan and Grant,

Here is the word file and the PDF with signed, signature page. Please let me know if you need anything else.



Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

Jack Housenger, Director
Office of Pesticide Programs

Date: 3/31/16

Summary

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing to grant an unconditional registration under Section 3(c)(5) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba on genetically-modified dicamba-tolerant cotton and genetically-modified dicamba-tolerant soybean. The proposed new uses will be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582), containing 58.1% of the active ingredient dicamba, diglycolamine salt (DGA) for pre- and post-emergence (in-crop) applications to dicamba-tolerant cotton and soybean.

The U.S. Department of Agriculture (USDA) granted deregulation status for dicamba-tolerant cotton and soybean on January 15, 2015 under the Plant Protection Act.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Proposed Product: M1691 Herbicide

Background

On April 28, 2010 and July 30, 2012, respectively, EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on genetically-modified dicamba -tolerant soybean and cotton.

Dicamba is an active ingredient that is used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The proposed new uses on cotton and soybeans would expand the current timing of dicamba applications to dicamba-tolerant soybeans and cotton. Dicamba is currently registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. The proposed use would add post-emergence (over-the-top) applications to dicamba-tolerant cotton and soybean crops.

Dicamba is a member of the Benzoic acid family of herbicides (Herbicide Resistance Action Committee (HRAC) Group 4). Dicamba works by increasing plant growth rate. Once sufficient concentration is reached, the plant outgrows its own nutrient supplies and ultimately dies.

This proposal discusses several Agency considerations of the proposed use for dicamba on dicamba-tolerant soybeans and cotton, including discussions of human health and environmental risks associated with the proposed uses. Due to the multiple forms of dicamba, EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the

assessment for human health considered data associated with the BAPMA salt of dicamba, even though this registration action is being proposed for a formulation containing only the DGA salt of dicamba. This is because the data on the BAPMA salt was relevant to the analysis and resulted in the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. On the other hand, assessments focus on effects of the DGA salt when product specific considerations are discussed. For example, to determine appropriate spray drift buffers, the Agency examined drift potential using studies conducted on the DGA salt formulation.

Proposed New Uses

Cotton

On currently registered dicamba products for use on conventional cotton, pre-emergence treatment can be made at 8 fluid ounces (0.25 lb a.e. dicamba) per acre per season. The maximum single/annual application rate proposed for use on dicamba-tolerant cotton for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use, for post-emergence (in-crop) application of dicamba for use on dicamba-tolerant cotton, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in dicamba-tolerant cotton is 64 fluid ounces (2.0 lb a.e. dicamba) per acre.

If a preplant application of 32 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for dicamba-tolerant cotton.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest retreatment interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

On currently registered dicamba products, the maximum single and maximum annual application rate allowed to both conventional and dicamba-tolerant soybeans for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use for post-emergence (in-crop) application of this product to dicamba-tolerant soybeans, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in soybeans is 32 fluid ounces (1.0 lb a.e. dicamba) per acre.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay is 14 days (R1 Growth stage).

Evaluation

In evaluating a pesticide registration application, the EPA assesses a wide variety of information on the pesticide's toxicity (*i.e.*, effects on humans and other non-target organisms), exposure (*i.e.*, where and how the pesticide is used), and environmental fate (*i.e.*, how the chemical will move in the environment) to determine the likelihood of adverse effects (*i.e.*, risk) to human health and the environment resulting from the proposed uses. Risk assessments are developed to evaluate the environmental fate of the compound as well as how it might affect a wide range of non-target organisms including humans, terrestrial and aquatic wildlife and plants. On the basis of these assessments, EPA evaluates and approves language for each pesticide label to ensure the directions for use and safety measures are appropriate to mitigate any potential risk. The pesticide's label helps to communicate essential limitations and mitigations that are necessary for public safety. Once the risks are assessed and mitigation measures have been incorporated, EPA balances any remaining potential risks against the benefits of the use of the product. EPA will grant an application if it determines that the benefits of the use of the product outweigh its risks.

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human health risk assessment for dicamba, risks were assessed in a manner that assures human health protection to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba in registered or proposed to be registered products that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data showing greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency seen with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the Agency assumes that any amount of

exposure will lead to some degree of risk. Thus, the Agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be “not likely” to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2) more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment of dicamba. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The Agency determined, based on a reviews of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, EPA assumes that any amount of exposure will lead to some degree of risk. Thus, EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainty factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and 1X for FQPA SF when applicable). The inhalation HEC/HED results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) For dicamba, there is no

evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits.

After considering the available toxicity data, EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the Agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in

the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models. Therefore, the Agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other substances. For the purposes of this Proposed Registration Decision, therefore, EPA has assumed that dicamba does not have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities.

Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the point of departure for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and proposed uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the Agency's LOC for both food and water. For the U.S. population the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being proposed for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application inhalation exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the proposed uses of dicamba on dicamba-tolerant corn and soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. Volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40 acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Results of PERFUM modeling, however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates are not of concern.

4. Spray Drift

Spray drift is always a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The proposed maximum single application rate of dicamba is 1 lb ae/A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. For the purposes of the proposed uses on dicamba, this is considered a screening level assumption since the proposed use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate 1 lb ae/A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the FFDCA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- and long-term durations via the oral, dermal, and inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and proposed use sites. Drinking water values were incorporated directly into the assessment.

The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term aggregate risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short term aggregate risks.

6. Long-term aggregate risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

7. Occupational Risk Assessment

a. Short- and Intermediate-term handler Risk

EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on genetically -modified cotton and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short and Intermediate term Post-application Risk

EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard *via* the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation post application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The Agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the Agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the Agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on dicamba-tolerant soybean and cotton is provided below. More detailed discussions can be found in the Agency documents titled, *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708)* and *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)*, and its addendums entitled, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean and Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean*. These documents are in the docket. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water

and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would likely persist; however, EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. It may reach surface water via field/site runoff, spray drift during application, and by vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however EPA does not expect DCSA to reach groundwater at levels that would be of concern. The major route of exposure to non-target organisms is likely spray drift and runoff. Also, multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury. The assessments related to these routes of exposure are described in the sections below.

3. Runoff

The Agency has considered the potential effects due to runoff, and has developed proposed mitigation to limit off-site runoff. A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following dicamba applications, likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The Agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). EPA has also determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. Based on the weight of evidence approach, EPA determined that labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (*i.e.* NOAEC for soybean plant height).

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, the Agency had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Though the Agency found the information helpful, the submission did not include enough detail to verify the measurements in the studies. Therefore, in order to be protective of potential effects to non-target plants from volatilization, labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate. Although the Agency is not requiring additional data to be submitted at this time, if EPA receives volatility data under varied conditions of temperature and relative humidity, as these factors play a strong role in volatility under field conditions, it may reconsider whether this mitigation requirement is necessary.

EPA is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being proposed by EPA (400 feet as opposed to 110 to 220 feet). EPA has reviewed the information associated with the larger buffer in Arkansas to assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (*i.e.*, plant height) for the most sensitive plant species tested (*i.e.*, soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the proposed uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are

drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the proposed label. The Arkansas Plant Board felt that a 400 foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic ($RQ = \text{Exposure} / \text{Toxicity}$). RQs are then compared to EPA's levels of concern (LOCs). The LOCs are criteria used by the Agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the Agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including cotton and soybean. The proposed uses on dicamba-tolerant soybeans and cotton would expand the timing of applications from pre-emergence and pre-harvest only for soybeans and pre-emergence and post-harvest only for cotton to allowing post-emergence over-the-top applications. The maximum yearly application rates would remain 2.0 lb a.e./acre for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./acre between pre-emergence and post-emergence applications.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad

default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations.

The results of the screening level risk assessments indicate that the RQs do not exceed the Agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the Agency's LOC. The screening level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both cotton and soybeans, based on the proposed maximum application rates, the screening level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the Agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans. Before considering mitigation measures, EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening level assessment, further refinement, as discussed below, suggest that risks are lower.

1. Risk to Birds

For birds, the screening level assessment indicated that the RQs exceeded the Agency's LOCs on an acute basis for both soybean and cotton. More specifically, the screening level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in dicamba-tolerant soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming soybean forage/hay.

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The Agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs.

Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns, suggesting that dicamba consumed in the diet may possibly be less available than assumed using dose-based exposures. Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger concerns for many food items. In addition, estimates of exposure in screening level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms with territories established at distance from the field. With this last line of evidence in mind, the draft pesticide label requires an in-field 110 to 220-foot buffer to further reduce off-site exposure for birds (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for birds feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

2. Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the Agency's LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening level assessment using the maximum exposure values from empirical datasets for DCSA residues in dicamba-tolerant soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. A screening level assessment using the maximum exposure values from empirical data for DCSA residues in dicamba-tolerant cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the draft pesticide label requires an on-field 110 to 220-foot buffer in all directions to further reduce off-site exposure for mammals (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for mammals feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an Agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the proposed uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift, and for dicots in semi-aquatic areas due to runoff and spray drift. The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that labeling restrictions will help to reduce spray drift off field. The registrant submitted additional studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and the formulation in its application for registration. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1691 herbicide when an adequate buffer is incorporated between the application equipment and the edges of the treated field.

Additionally, to further mitigate against potential risks to plants from spray drift, the product labeling requires the use of 110-220 foot (depending on application rate) buffer between the last treated row and the closest edge of the field to be treated (in all directions). The Agency considered exposure to spray drift to be the principal risk issue associated with the proposed labeled use for all taxa. EPA considered a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting.

4. Synergism

EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. In EPA's risk assessments, the Agency uses GLP guideline studies to determine potential toxicity to plants, involving apical endpoints such as biomass and reproductive health. EPA believes this approach is very reliable for these purposes. However, at this time, the topic of synergy and multiple stressors is an uncertainty in assessing risk to non-target plants including endangered

species. Therefore, EPA is proposing a tank mix prohibition on the M1691 label to address this uncertainty.

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this proposed decision.

In the screening level risk assessment performed for the new application timing of dicamba (DGA) on genetically modified cotton and soybean to be tolerant to dicamba, EPA determined that direct concerns were unlikely (*i.e.* levels of concern were not exceeded) for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <https://www.epa.gov/endangered-species/ecological-risk-assessment-process-under-endangered-species-act>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still

exceeds the Agency's levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species' habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

This registration for dicamba is being proposed for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an assessment of listed species is completed for any such state.

Based on EPA's LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), EPA identified the listed species that are inside the "action area" (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 30 states.

The following criteria were used to assess listed species in the action area:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have "no effect."
- For listed individuals outside the action area, use of a pesticide would be determined to have "no effect."
- Listed individuals inside the action area may either fall into the "no effect" or "may effect" categories depending upon their specific biological needs and circumstances of exposure.

- Those that fall under the “may effect” category are found to be either “likely” or “not likely to be adversely affected.” This determination is made in consultation with the Services
- A “likely” or “not likely to adversely affect” determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift mitigation language including a 360 degree infield buffer (to varying length, depending on application rate) on the label is intended to limit off site transport of dicamba DGA through spray drift, as well as volatilization. Therefore, EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, EPA concluded a no effect determination for all but 24 species originally identified as potentially at-risk (in the screening level assessment) because they are not expected to occur on cotton and soybean fields. The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in EPA’s refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, EPA made a determination that exposure occurring on the field would have “may affects” (either “unlikely to adversely affect” or “likely to adversely affect” on 2 species (the Spring Creek Bladderpod and the Audubon Crested Caracara) in 2 counties (Wilson county, TN and Palm Beach county, FL, respectively) within the States covered by this proposed decision. Furthermore, the Agency has concluded that the 2 species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in both counties, thus mitigating any possible chance of exposure.

Additionally, the Agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, EPA’s analysis supports a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, EPA is proposing to require rainfast mitigation on the label (“Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.”) to protect against the risk of exposure to listed species off the treated field.

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on genetically-modified crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, EPA is proposing, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a

lack of performance can communicate directly with Monsanto by a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the proposed uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label. The registrant must then evaluate the situation to determine if lack of performance is caused by resistance or likely resistance.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy^[i], et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers’ permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15th, 2018, on or before January 15th of each year, Monsanto must submit annual summary reports to EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, county and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The

annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the proposed dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The Agency received 11 comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2010-0496) for the application to register the use of dicamba on genetically-modified soybeans and no comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2012-0841) for the application to register the use of dicamba on genetically-modified cotton. The majority of comments expressed concern (e.g., spray drift and volatilization) and requested that the Agency deny the proposed registration. The EPA welcomes input from the public during the decision process when registering pesticides, and is committed to thoroughly evaluating and mitigating any potential risks from registered pesticides, consistent with applicable statutory standards. EPA considered the public comments received in this regulatory decision.

The commenters focused on spray drift and volatilization concerns affecting non-target plants. The Agency has evaluated the risks regarding the potential drift of pesticides to sensitive crops and other non-target plants that may be adjacent to treatment areas. Specific label directions and restrictions have been proposed to protect from off-target movement of this pesticide product. Specifically, the proposed registration decision requires a 110-220 foot buffer between the treated area and edge of the field in all directions. These buffers are expected to keep spray drift from moving beyond the edge of the crop field to be treated as well as reduce the concern for volatility. In addition, the label will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide to distances within these buffers. The proposed regulatory decision also specifies that this product cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. Label language regarding spray volume, equipment ground speed, and spray boom height is intended to further protect against off-target drift. More details on EPA's and Monsanto's efforts to minimize effects to non-target plant species can be found in Section VIII.B.4 of this document.

Commenters also expressed concerns that weeds resistant to dicamba will become more prevalent as a result of this proposed use. Weed resistance is an increasing problem that has become a significant economic issue to growers. In an effort to address this concern and to prevent new weed resistance from happening, while giving growers another essential tool in their integrated pest management programs, Monsanto must put into place a stewardship program to promote responsible use of the proposed product in order to minimize the potential for increased

levels of weed resistance. This plan is discussed in detail in Section V and Section VIII.B.3 of this document.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Current registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the currently registered use of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba would expand weed management options on genetically-modified cotton and soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season would target new flushes of weeds, thereby reducing populations of these weeds and particularly would help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Proposed Registration Decision

In accordance with FIFRA, EPA only registers a pesticide when it can ensure that it will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, EPA is charged with balancing the uncertainties and risks posed by a pesticide against its benefits. EPA must determine if the benefits in light of its use outweigh the risks in order for the Agency to register a pesticide.

In the case for the proposed use of dicamba on dicamba-tolerant soybeans and cotton, and in consideration of all best available data and assessment methods, EPA believes this proposed decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. The Agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some levels of concern were exceeded for certain birds and mammals that may be in the fields that would be treated. The Agency notes that these are very conservative risk estimates using screening level (worst case) assumptions, and that they most likely do not apply to the majority of the birds and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated

field. Because of these additional restrictions, EPA expects the proposed uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the Agency's levels of concern.

On the benefits side of the analysis, use of dicamba on dicamba-tolerant soybeans and cotton is expected become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of U.S. soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states stretching across the southern half of the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on dicamba-tolerant soybeans and cotton would be beneficial as it provides an effective tool to treat especially noxious weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba could help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to soybean and cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the proposed labeling restrictions will include protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

After weighing all the risks of concern against the benefits of the proposed uses, EPA finds that when the proposed mitigation measures are applied, the risks that may remain are minimal, if they exist at all, while the benefits are potentially great. Therefore, the benefits outweigh the risks and registering these uses will not generally cause unreasonable adverse effects on human health or the environment during the 5-year time limited registration being proposed (a 5-year registration is proposed so that any unexpected weed resistance issues that may result from the proposed uses can be addressed before granting an extension or EPA can allow the registration to terminate if necessary). EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(5) registration finding for the proposed uses.

A. Data Requirements

There are no outstanding data requirements required to support the registration of this action. However, data may be required in connection with registration review activities for dicamba. Those requirements would be generic to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the proposed supplemental labels unless otherwise noted below.

1. **Worker Protection** *(Although the following Worker Protection labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. **Environmental Hazards** *(Although the following Environmental Hazards labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1691™ for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call XXXXXXXX.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless in conjunction with another mode of action herbicide with overlapping spectrum.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use the Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying M1691 Herbicide. Do not use any other nozzle and pressure combination not specifically allowed by this label.

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and are impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical

air mixing. The inversion will dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

a. Buffer

Maintain a 110-foot buffer (when applying 16 fl oz of this product per acre), or a 220-foot buffer (when applying 32 fl oz of this product per acre) between the treated area and the edge of the field in all directions.

b. Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1691 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1691 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.

- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans.
- The combined total application rate from crop emergence up to 7 days pre-harvest must not exceed 64 fluid ounce (2.0lb a.e dicamba) per acre for cotton.
- All applications for both cotton and soybeans must not exceed 64 fluid ounces (2.0 lb a.e dicamba) per acre.

C. Registration Terms

EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. EPA is basing the proposed registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

Monsanto must have an Herbicide Resistance Management (HRM) Plan for M1691 Herbicide developed and approved by EPA before a final registration can be issued. The HRM Plan must focus on educating growers on the appropriate use of the M1691 Herbicide and the associated dicamba-tolerant seeds. EPA is requiring that the HRM Plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

Monsanto or its representative must investigate reports of lack of herbicide efficacy as reported by users following “scouting.” When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for “likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Additionally, Monsanto must collect material, if possible, for further testing. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if

requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures.

c. Annual Reporting of Herbicide Resistance to EPA

Monsanto must submit annual summary reports to EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, county and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

2. EPA's Continued Control over the Registration

Because the issue of weed resistance is an extremely important issue to keep under control and can be very fast moving, this registration will expire 5 years from the date of the registration issuance, unless this term is removed or modified by EPA. At the end of 5 years, EPA can work to address any unexpected weed resistance issues that may result from the proposed uses before granting an extension or allow the registration to terminate if necessary.

3. Geographic Limitation on Use of Dicamba M1691 Herbicide

EPA is proposing to issue this registration only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62.
<http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean

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THRU: Mark Corbin, Branch Chief *Mark Corbin 3-24-16*
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This is an addendum to the Environmental Fate and Effects Division's (EFED) ecological risk assessment for dicamba DGA salt (Clarity[®] formulation or M169I, EPA Reg No. 524-582) and its degradate, 3,6-dichlorosalicylic acid (DCSA), for the proposed new use on dicamba-tolerant soybean. It includes analysis of information that was not previously included in the original soybean new use risk assessment (USEPA, 2011, DP 378444). Since the original risk assessment was conducted, the registrant, Monsanto, has submitted:

- 1) field trial data that impacts EFED's previous analysis of spray drift,
- 2) data for incidents and inquiries from the use of dicamba DGA salt,

- 3) laboratory volatility data for dicamba DGA and DMA salt formulations, and
- 4) terrestrial plant reproductive effects data.

Additionally, this addendum includes analysis conducted by EFED regarding:

- 5) the implication of new mammalian chronic effects endpoints for parent dicamba and the metabolite DCSA from the Health Effects Division (HED; USEPA 2016, D378366+),
- 6) a revised T-REX run using refined estimates of foliar dissipation half-lives and variable application rates,
- 7) the potential for effects to beneficial terrestrial invertebrates,
- 8) effects posed by runoff, and
- 9) potential synergistic interactions with glyphosate.

1. Spray Drift and Buffers (Field Trial Data)

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that the distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate). However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect

distance for sensitive plants (the “no-effect” distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto’s statement that the field trial data are not suitable for use in EPA’s regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical

endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED's Process to Determine a "No Effect" Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered "controls," though there are considerable uncertainties to this approach. Specifically, no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these "controls" the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the "control" means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a "no effect" distance at each site was considered the first distance greater than the maximum distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the "no effect" distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.e./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 1. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than only 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Weight of Evidence Conclusions

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of this field trial data is not suitable for the purpose of establishing an appropriate buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.e./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTII 1004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate and with the described nozzles restricting the droplet spectra extra-coarse and ultra-coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

2. Incidents

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in

place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (e.g. burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (e.g. leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EIIIS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. The air temperature and humidity at the time of dicamba application were reported to be 82°F and 55%, respectively. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8

µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements, as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty whether this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing. Further discussion of volatility is provided in **Section 3** below.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where "dicamba type" damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto's submitted information on the 73 incidents from 2012-2014 (discussed previously in this section). With the current information available, and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri). The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made.

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that were not followed included tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EHS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants, and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize since the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more likely impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory data conditions. Additional discussion and characterization of volatility is provided in the next section.

3. Volatility

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, because these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 lb a.e./A application rate and 220 feet for the 1.0 lb a.e./A application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However, consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the previous section (MO Case File #81513M00701, EIIIS Incident report number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

4. Potential Effects on Terrestrial Plant Reproduction

EFED is aware of published literature associating dicamba applications with effects to soybean progeny. These studies indicate potential effects to the quantity and reproductive quality of future soybean generations following dicamba applications that would not be observed in the guideline vegetative vigor and seedling emergence studies EFED typically uses to assess risk to terrestrial plants. Therefore, these data raise a potential concern that has not been directly addressed in OPP assessments, should these effects occur at lower exposures than the effects observed in the guideline terrestrial plant studies. In meetings and email correspondence in January/February, 2015, OPP asked whether Monsanto was aware of this issue. Monsanto requested the references that OPP was aware of, so that they could independently review them.

Monsanto reviewed the open literature references provided by OPP and stated that none of the studies described effects on progeny at application rates lower than OPP's lowest available regulatory endpoint from the available vegetative vigor plant study (0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), therefore any mitigations (*i.e.* spray drift buffers) based on the plant height endpoint would be protective for effects to progeny.

The open literature studies examined seeds/pod, seed weight, seed quality, delayed maturation, pod malformation, reduced germination or progeny emergence, and malformed progeny. The vast majority of the studies did not investigate effects at rates as low as the NOAEC from the available vegetative vigor study. Monsanto's review of the available information indicated that the lowest effects endpoint reported from these studies was for delayed maturation of soybeans at rates as low as 0.56 g a.e./A from Kelley *et al.* (2005), which would still be almost 2 times less sensitive than the regulatory endpoint based on plant height that EFED has used in its risk assessments. Monsanto concluded that the open literature studies did not contain information that indicated that the in-field buffer based on plant height that is on the draft label would not also be protective of these reproductive effects.

EFED acknowledges Monsanto's submission of their analysis of the open literature data for effects to progeny, but to date has not independently reviewed each of these studies. However, for the following reason, EFED does not believe the information would change its risk assessments. The most sensitive endpoint reported in the open literature was a LOAEC of 0.56 g a.e./A for delayed maturation of soybeans (Kelley *et al.*, 2005; no NOAEC reported). As EFED's determination for risk to listed plant species is based on the most sensitive apical endpoint (*i.e.*, the NOAEC for soybean plant height from the available vegetative vigor study with dicamba DGA, 0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), less sensitive endpoints reported in the literature for effects to progeny would not impact EPA's risk assessments. EFED's policy regarding open literature is that typically if endpoints from the open literature are not more sensitive than guideline endpoints, then further analysis is not required (USEPA, 2011b)

5. Revised Terrestrial Vertebrate Endpoints

Parent Dicamba

The risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016, D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. The revised T-REX run presented in **Section 6** of this addendum reflects the adjusted chronic endpoint for parent dicamba.

Metabolite DCSA

Following preliminary review of a rat 2-generation study with DCSA (MRID 47899517), the risk assessment for the proposed new use on soybeans (USEPA, 2011 D378444) used a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016) was completed to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016) determined BMD₅ (estimated benchmark dose [BMD] to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised T-REX analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

6. Revised T-REX Analysis for Parent Dicamba and Quantitative Assessment of DCSA Exposure and Risk

Dicamba-specific Half-Life

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. However, EFED has refined this analysis by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application); a chemical-specific foliar dissipation half-life value for parent dicamba

(described below); and the new chronic mammalian endpoint for parent dicamba (described previously in **Section 5**).

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 2**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 2. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Parent Dicamba T-REX Analysis

Modeled maximum residue values (EECs) determined using this refined approach were slightly higher (~15%) than those determined in the original dicamba-tolerant soybean Section 3 assessment, but would not have impacted the screening-level risk conclusions for any assessed taxa. The previous risk assessment (2011) concluded that there was potential for direct adverse effects to mammals from chronic exposures of dicamba (max chronic RQ was 2.31 for small mammals consuming short grass). Following the refinements presented in this section (3 applications of dicamba to include the two post-emergent applications at the 0.5 lb a.e./A rate, foliar dissipation half-life decreased from 35 days to 8.4 days, and an increase in the mammalian chronic endpoint from 45 mg/kg-bw to 136 mg/kg-bw), there are no longer any exceedances for any size class of mammal consuming any dietary item (max RQ = 0.84, see **Appendix 1** for full T-REX input and output)

DCSA Metabolite Exposure Analysis

Since the chronic toxicity endpoints are more sensitive for DCSA than dicamba and DCSA residues were higher than dicamba residues within dicamba-tolerant soybean plant tissues (see below), EFED separately assessed the chronic exposure to DCSA residues for birds and mammals.

The available data indicate that DCSA has similar acute toxicity as parent dicamba, but is substantially more toxic on a chronic basis to mammals. In conventional soybean plants, DCSA residues following dicamba applications prior to planting were less than 2% of total dicamba residues in forage, hay and seed (MRIDs 43814101 and 44089307; max of 0.130 ppm DCSA, see **Appendix 2**) and would not be above toxicity thresholds for any taxa. However, in dicamba-tolerant soybean plants, dicamba is converted to DCSA and its glycosidic conjugates following demethylation of the aromatic methoxy moiety of dicamba (USEPA, 2013. HED residue chemistry summary) and in comparison to dicamba use on conventional soybeans, the maximum residues of DCSA in dicamba-tolerant soybean field trials following one 1-lb/A pre-emergent application and two 0.5-lb/A post-emergent applications were a substantially higher proportion of dicamba-related residues in forage, hay and seed (**Appendix 2** and MRID 47899524; 76%--88% of total dicamba-related residues). The empirical data from MRID 47899524 found means and maximums, respectively, of DCSA concentrations of 17.0 and 51.3 ppm, in forage 7-10 days following the last application, 32.2 and 61.1 ppm in hay 13-15 days following the last application and 0.059 and 0.440 ppm in seeds 73-98 days after the last application. EFED used the maximum measured values from the empirical data on forage, hay and seeds to assess risk to terrestrial vertebrates. There is some uncertainty in this approach as the maximum DCSA residues appear to be slightly increasing (16%) between forage at 7-10 days and hay at 13-15 days, however this could be due to the difference between fresher forage and drier hay, where DCSA has become more concentrated compared to the overall plant biomass, rather than due to additional conversion of dicamba residues to DCSA. Additionally, the amount of additional dicamba available to potentially convert to DCSA appears limited after this point as the maximum residues of dicamba were only 2.62 and 1.16 ppm in forage and hay, respectively.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-soybean and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization. This is because the conversion of dicamba to DCSA in plants is only expected to occur in crops modified to be tolerant to dicamba.

DCSA Effects Assessment

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds, resulting in a chronic avian endpoint of 40.9 mg/kg-bw. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who would not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into the egg during egg development).

Using the empirical dataset for DCSA residues in DT-soybean crops (as described above), the maximum residues in soybean forage and hay tissue were 61.1 ppm and in seeds were 0.440 ppm. Residues in arthropods (as a dietary item for birds and mammals consuming insects that

have consumed soybean tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications and therefore were considered to contain 42.5 ppm. This is likely conservative, given that the residues from the nomogram are for external residues in food items following a spray application while the actual exposures would be internal residue concentrations in the plant. A screening assessment using this empirical data for the exposure values results in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay tissue or consuming insects that had consumed soybean tissues with DCSA residues (RQs range from **1.1—3.3**, **Table 3**), for small birds consuming forage and hay tissue or insects that had fed on DT-soybean tissues, (RQs range from **1.2—1.7**, **Table 4**) and medium birds feeding on forage/hay tissue (marginal exceedance of **1.0**) but no exceedances occurred for any size mammalian or avian granivore consuming soybean grain (max granivore RQ of < 0.01).

Table 3. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-soybean tissues containing DCSA residues (maximum 61.1 mg/kg in forage/hay, 0.44 mg/kg in seeds) or consuming arthropods that had fed on DT-soybean tissues (assumed to contain 42.5 mg/kg DCSA). Bold RQ values exceed the LOC.

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Forage/Hay	0.0143	58.25	6.2	3.3
	Seed	0.00318	0.09	6.2	<0.01
	Arthropod	0.0143	40.52	6.2	2.3
Medium (35g)	Forage/Hay	0.0231	40.33	14.2	2.8
	Seed	0.00513	0.06	14.2	<0.01
	Arthropod	0.0231	28.05	14.2	2.0
Large (1000g)	Forage/Hay	0.153	9.35	17.6	1.5
	Seed	0.0340	0.01	17.6	<0.01
	Arthropod	0.153	6.50	17.6	1.1

Table 4. Dose-based exposure and risk quotients for birds consuming DT-soybean tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA for birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Forage/Hay	0.0228	69.65	40.9	1.7
	Seed	0.0051	0.11	40.9	<0.01
	Arthropod	0.0228	48.45	40.9	1.2
Medium (100g)	Forage/Hay	0.0649	39.65	40.9	1.0
	Seed	0.0144	0.06	40.9	<0.01
	Arthropod	0.0649	27.58	40.9	0.7
Large (1000g)	Forage/Hay	0.291	17.78	40.9	0.4
	Seed	0.065	0.03	40.9	<0.01
	Arthropod	0.291	12.37	40.9	0.3

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-soybean tissues (forage from days 7-10, hay from days 13-15 and seeds from

days 73-98) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-soybean plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure.

As noted above, EFED calculated these RQs based on the female lactation dose NOAEL endpoint of 8 mg/kg/d from the DCSA 2-generation study where reductions of up to 9% pup body weight were observed 2-3 weeks post birth at the next highest dose (78 mg/kg/d). If the BMDL₅ (the lower 95% confidence level on the estimated benchmark dose to result in a 5% body weight change in pups from background levels) of 34.9 mg/kg/d calculated by HED (EPA, 2016) for DCSA was used in place of the NOAEL, then the maximum residues from the empirical data in soybean hay would be below the threshold dose for all size classes of mammals feeding on soybean plant tissue or soybean-consuming arthropods (RQs would range from 0.35—0.76 for mammals feeding on tolerant soybean tissues and 0.24—0.53 for mammals feeding on arthropods having consumed soybean tissues).

7. Terrestrial Invertebrates Risk Characterization

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum¹ establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This addendum document explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial

¹ <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact $LD_{50} > 91 \mu\text{g a.e./bee}$ (MRID 00036935). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LD_{50} (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate ($1.0 \text{ lbs a.e./A} \times 2.7 \mu\text{g a.e./bee}$ (upper bound for contact exposures from a direct spray of 1 lb a.e./A , based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 ($2.7/91$) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral $LC_{50} > 100 \mu\text{g a.e./bee}$). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC_{50} (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of $32.12 \mu\text{g/bee/bee/day}$ ($1.0 \text{ lb a.e./A} \times 110 \mu\text{g a.e./g}$ {upper-bound residue for tall grass from T-REX} $\times 0.292 \text{ g/day}$ {pollen consumption rate}), the resultant RQ would be 0.32 ($32.12/100$) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may

² The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured. Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the soybean risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ³	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁴

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

³ Test material was dicamba BAPMA salt

⁴ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated contact-based bee chronic NOAEC of 38 µg a.e./bee. The acute dietary estimated exposure level for adult honeybees is 32.12 µg/bee/day for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 µg a.e./bee. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (*e.g.*, an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary

exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate developmental life stages and survival in organisms following prolonged exposure); and
2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the soybean risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning in summer, 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC_{50} of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-soybean plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

8. *Runoff*

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). According to the original ecological risk assessment (USEPA, 2011a), dicamba is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 3** for calculations). Using these assumptions in TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 3**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

9. *Herbicide Interactions (Synergism)*

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba

and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent application (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans

Chemical Identity and Application Information				Application No.	Rate	Day of Application
Chemical Name:	Dicamba			1	1	0
Seed Treatment? (Check if yes)	<input type="checkbox"/>			2	0.5	7
Use:	cropcare			3	0.5	14
Product name and form:				4		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%			5		
Half-life (days):	8.4			6		
Are you assessing applications with variable rates or intervals?	yes			7		
Assessed Species Inputs (optional, use defaults for RQs for national level assessments)				8		
What body weight range is assessed (grams)?	Birds	Mammals		9		
Small	20	15		10		
Medium	100	35		11		
Large	1000	1000		12		
Reset Model				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		
				21		
				22		
				23		
				24		
				25		
				26		
				27		
				28		
				29		
				30		

The value in G6 must be zero

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	
LD50 (mg/kg-bw)	188.00	Subacute oral	
LC50 (mg/kg-diet)	10000.00	Subacute oral	
NOAEL (mg/kg-bw)		Subacute oral	
NOAEC (mg/kg-diet)	695.00	Mixed oral	
Enter the Mineau et al. Scaling Factor		1.15	
Mammalian			
Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			Reference (MRID)
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose	2720	mg/kg-diet based on standard FDA lab rat conversion	

Optional Test Organism Body weight (g)	Optional Test Species Name	Toxicity Value Reference (MRID)

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.87	4.16	0.03
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.39	2.37	0.01
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.12	1.06	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients

NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.0163	3.4819	0.0006
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.0139	2.4065	0.0005
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.0075	0.5579	0.0003

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.33	3.48	0.01
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.28	2.41	0.01
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.15	0.56	0.01

Appendix 2. Dicamba Crop Field Trial Residue Data Which Include the Determination of the DCSA Metabolite.

Table 1. Summary of Residues from Conventional Asparagus Crop Field Trials with DCSA as a Dicamba Residue of Concern.¹

Formulation ²	Total Application Rate (lb ae/A)	PHI (days)	N ³	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁵	HAFT ⁵	Median ⁵	Mean ⁵	SD ⁵
4 lb ae/gal DGA SL, 4 lb ae/gal DGA SL, and 2 lb ae/gal Na SL	Single post-emergence broadcast application of 0.5 lb ae/A	1	24	Parent	0.266	3.274	0.304	3.144	0.604	0.967	0.852
				DCSA ⁴	<0.01	0.071	<0.01	<0.040	0.011	0.014	0.0069
				Total	0.271	3.192	0.314	3.166	0.622	0.981	0.854

¹ Asparagus data are taken directly from MRID Nos. 43245206 and 43425803 (D204488, D204809, and D209229, L. Cheng, 07/14/1997) used for tolerance re-assessment in the 2005 RED.

² Test applications included the dimethylamine (DMA), diglycolamine (DGA), and sodium (Na⁺) salt formulations.

³ number of samples.

⁴ DCSA is the 3,6-dichloro-2-hydroxybenzoic acid metabolite.

⁵ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 2. Summary of Residues from Conventional Soybean Crop Field Trials (Seed) with DCSA as a Dicamba Residue of Concern.^{1,2}

Formulation ³	Total Application Rate (lb ae/A)	PHI (days)	N ⁴	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁶	HAFT ⁶	Median ⁶	Mean ⁶	SD ⁶
4 lb ae/gal DMA SL	Single 0.5 lb ae pre-plant treatment followed by a single post-emergence application of 2.0 lb ae/A	7	24	Parent	0.027	8.10	0.038	7.40	0.72	1.022	1.703
				DCSA ⁵	<0.01	0.130	<0.01	<0.048	.014	0.02	0.015
				5-OH dicamba	<0.01	0.360	<0.01	0.26	0.01	0.043	0.071
				Total	0.047	8.14	0.084	7.44	0.768	1.085	1.713

¹ Soybean grain data are for the 1X rate which used a 0.5 lb ae/A treatment made at 14-days pre-planting followed by a 2.0 lb ae/A treatment made at 7-days prior to harvest taken directly from MRID Nos. 43814101 (D223283, S. Knizner, 07/29/1996) and 44089307 (D228703, S. Chun, 07/16/1998) used for tolerance reassessment in the 2005 RED.

² The registrant was not supporting tolerances for soybean forage and hay at this time in lieu of a feeding restriction placed on the label. However, data were included for these commodities in the study submissions acquired using a single 0.5 lb ae/A treatment made at 14-days pre-planting (0.25x the maximum rate). Total residues of dicamba (parent, DCSA, and 5-OH dicamba) were <0.03 - <0.097 ppm in soybean forage and <0.03 - <0.04 ppm in soybean hay.

³ Test applications included the dimethylamine (DMA) salt formulation.

⁴ number of samples.

⁵ DCSA is the 3,6-dichloro-5-hydroxybenzoic acid metabolite.

⁶ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 3. Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

¹ Except for sample min/max, values reflect per trial averages; n = no. of field trials. For calculation of median, mean, and standard deviation, the LOQ (0.02 ppm each analyte in undelinted cotton seed and 0.04 ppm for each analyte in cotton gin byproducts) was used for any results reported as <LOQ in Table C.3. Combined residues of dicamba, 5-OH dicamba, DCSA, and DCSA are expressed in parent equivalents. Individual analyte results are reported as per se. N/A = Not applicable.

² LAFT = lowest-average-field-trial; HAFT = highest-average-field-trial.

Table 4. Summary of Residues from Dicamba-Tolerant Soybean Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Total Applic. Rate lb a.e./A (kg a.e./ha)	PHI (days)	Residue Levels ^{a, b} (ppm)						
			N	Min.	Max.	HAFT	Median (STMdR)	Mean (STMR)	Std. Dev.
DCGA ^c									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	0.356	5.90	5.27	1.93	2.02	1.02
Hay		13-15	44	0.167	7.26	7.19	2.00	2.66	1.91
Seed		73-98	44	<0.011	0.135	0.131	0.017	0.032	0.029
DCSA									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	8.92	51.3	50.4	15.0	17.0	8.00
Hay		13-15	44	12.2	61.1	60.7	31.9	32.2	11.2
Seed		73-98	44	0.010	0.440	0.439	0.033	0.059	0.089
Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	2.62	2.47	0.068	0.374	0.603
Hay		13-15	44	<LOQ	1.16	1.01	0.051	0.130	0.216
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
5-OH Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	0.009	0.009	0.005	0.006	<LOQ
Hay		13-15	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

^aConcentrations of the individual analytes are reported as dicamba equivalents

^bValues < LOQ are assumed to be at the LOQ.

^c DCGA residues were quantitated by a non-validated method

Appendix 3: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in **Table 1** for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure 1**. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in **Tables 2** and **3**.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%). In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40	105

°Lat	
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

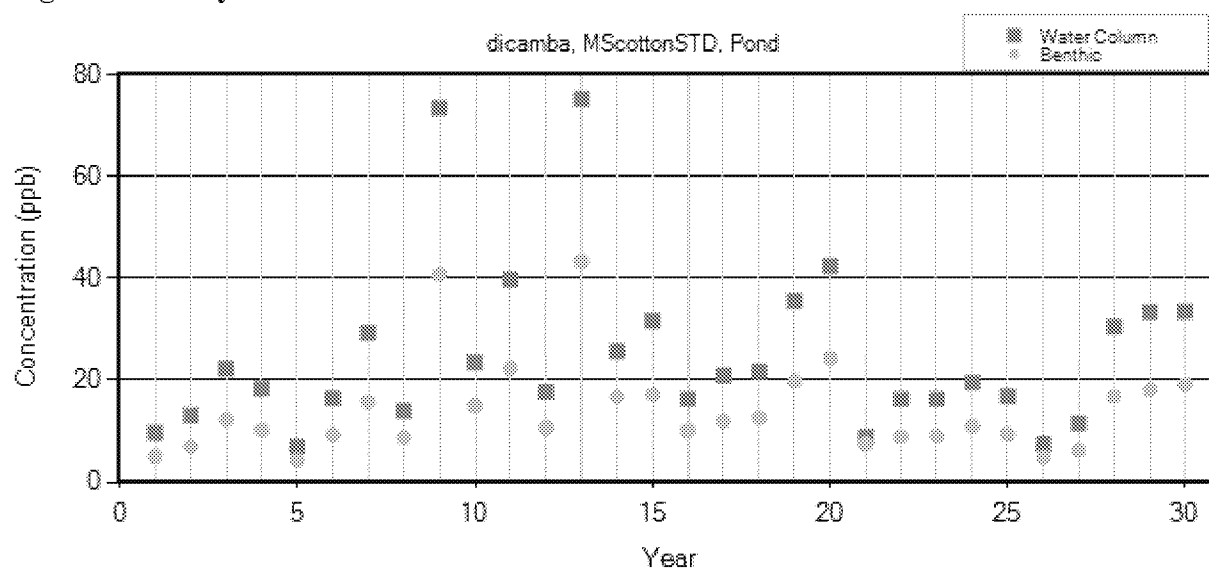


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (102,790 \text{ L water/ Acre-in}) * (1 \text{ inch}) * (1 \text{ lb/ } 453,592 \text{ mg})$
which reduces to:

Equation 2.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (0.226613)$

$EEC \text{ lb ai/A} = 0.061 \text{ mg/L} * 0.226613 = 0.0138$

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be $EEC \text{ lb ae/A} = 0.005 \text{ mg/L} * 0.226613 = 0.0011$. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e./A application rate and 0.06% loss through runoff and erosion.

Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48

Appointment

From: Mroz, Ryan [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2361A6C493144E738C334D77DD61547C-MROZ, RYAN]
Sent: 7/18/2016 7:13:08 PM
To: Odenkirchen, Edward [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=47e6bf402eed49ca8172e0849067d334-Edward W Odenkirchen]; Sankula, Sujatha [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=acedcc2399874e3085545a82e6a514a6-Sujatha Sankula]
Subject: QPE ESA Language
Attachments: 128931_425049_Phase 3+4 States ESA Assessment_Final Draft 3-14-16.docx; 128931_422305_Phase 2 States ESA Assessment_3-9-16_Final Draft.docx; 128931_416416+_ESA Phase 1 Assessment_3-8-16_Final Draft.docx; 128931_D426789_S3NUse_2nd Addendum_3-2-16_CLEAN_OGC cmts-03-03-16.docx
Location: DCRoomPYS12671/Potomac-Yard-One
Start: 7/19/2016 1:30:00 PM
End: 7/19/2016 2:00:00 PM
Show Time As: Tentative

Ex. 5 - Attorney Client



128931_D42678...
Addendum_3-2-1...



128931_416416+...
Phase 1 Assess...



128931_422305_...
2 States ESA As...



128931_425049_...
3+4 States ESA ...

Let's meet quickly to discuss if anything else may be necessary.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *EW* 3/24/16
Elizabeth Donovan, Biologist *ED* 3/24/16
William P. Eckel, Ph.D., Senior Science Advisor *WPE* (For BE) 3-24-16
Amy Blankinship, Senior Science Advisor *AB*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II® XTENDFLEX™ cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

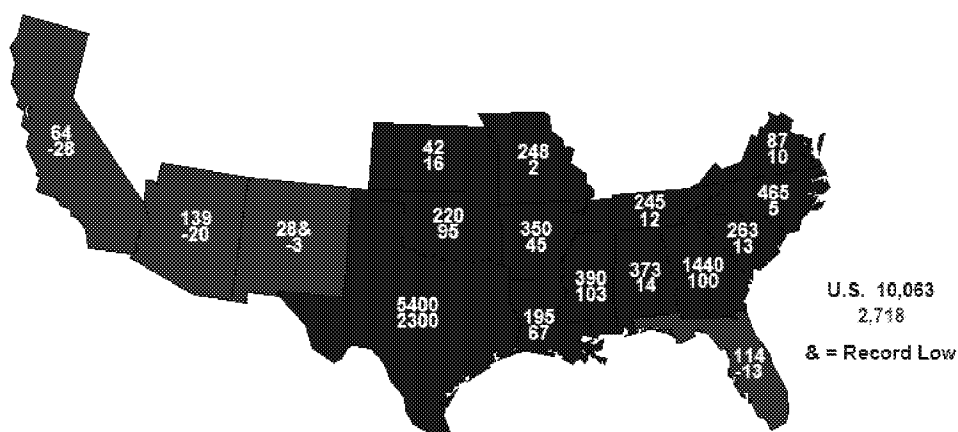
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3** and **4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _∞ (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and ***bold italicized*** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
	Arthropod	0.0143	4.19	17.58	0.24
Medium (35g)	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
	Arthropod	0.0231	2.90	14.23	0.20
Large (1000g)	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall.

However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-course droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TT111004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, than given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	Seeding Rate (lbs/acre)	18.9
Seed Treatment? (Check if yes)	<input type="checkbox"/>		
Use:	cotton, all or unspecified		
Product name and form:			
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%		
Half-life (days):	8.4		
Are you assessing applications with variable rates or intervals?	yes		

Do NOT specify application day at Column F and % of day later than up to 30 applications.

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
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16		
17		
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19		
20		
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25		
26		
27		
28		
29		
30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	Optional Test Species Name
Mammalian			
Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	Reference (MRID)
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

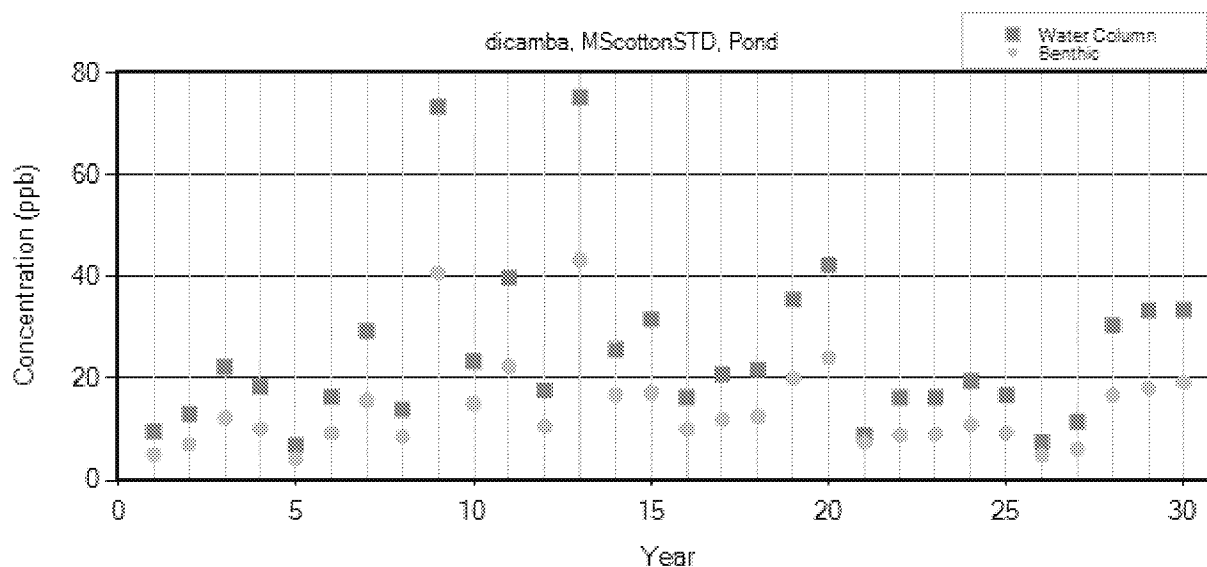


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48

Message

From: Riggs, Rebecca [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=04145AE545394051BA6A9BB9735F6CBC-REBECCA RIGGS]
Sent: 5/13/2016 7:00:29 PM
To: Overbey, Dian [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a2661c036319411f99982286e694c8d5-Dian D Overbey]
CC: Kaythi Han [Han.Kaythi@epa.gov]
Subject: E-mailing: Becky Files.zip
Attachments: Becky Files.zip

Dian – Could you please save the attached file to the CSB I drive for me please? I’ve already lost access to the OPP area and can now see OAR!

Thanks!

Becky

EPA Extends Comment Period on Proposed Decision to Register Dicamba for Use on Genetically-Engineered Crops

In response to requests, the EPA is extending for an additional 30 days the public comment period on the proposed regulatory decision to register dicamba to control weeds in cotton and soybean genetically engineered (GE) to tolerate dicamba. Public comments on the Agency's proposed regulatory decision must be submitted no later than May 31, 2016. Comments may be submitted to the EPA docket EPA-HQ-OPP-2016-0187 at www.regulations.gov.

These GE cotton and soybean plants are the first developed to be resistant to dicamba and are intended to allow farmers to use dicamba to control weeds that have developed resistance to glyphosate and other herbicides.

After the comment period closes, EPA will review all of the comments and reach a final decision, which the Agency expects to issue in late summer or early fall 2016.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 426789
Date: March 24, 2016

MEMORANDUM

SUBJECT: Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *m/wagman 3/24/16*
Amy Blankinship, Senior Science Advisor *Blankinship 3-24-16*
William P. Eckel, PhD., Senior Science Advisor *W. P. Eckel (For BE) 3-24-16*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *Mark Corbin 3-24-16*
Monica Wait, RAPL *Monica Wait 3/24/16*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

This is an addendum to the Environmental Fate and Effects Division's (EFED) ecological risk assessment for dicamba DGA salt (Clarity[®] formulation or M169I, EPA Reg No. 524-582) and its degradate, 3,6-dichlorosalicylic acid (DCSA), for the proposed new use on dicamba-tolerant soybean. It includes analysis of information that was not previously included in the original soybean new use risk assessment (USEPA, 2011, DP 378444). Since the original risk assessment was conducted, the registrant, Monsanto, has submitted:

- 1) field trial data that impacts EFED's previous analysis of spray drift,
- 2) data for incidents and inquiries from the use of dicamba DGA salt,

- 3) laboratory volatility data for dicamba DGA and DMA salt formulations, and
- 4) terrestrial plant reproductive effects data.

Additionally, this addendum includes analysis conducted by EFED regarding:

- 5) the implication of new mammalian chronic effects endpoints for parent dicamba and the metabolite DCSA from the Health Effects Division (HED; USEPA 2016, D378366+),
- 6) a revised T-REX run using refined estimates of foliar dissipation half-lives and variable application rates,
- 7) the potential for effects to beneficial terrestrial invertebrates,
- 8) effects posed by runoff, and
- 9) potential synergistic interactions with glyphosate.

1. Spray Drift and Buffers (Field Trial Data)

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that the distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate). However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect

distance for sensitive plants (the “no-effect” distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto’s statement that the field trial data are not suitable for use in EPA’s regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical

endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED's Process to Determine a "No Effect" Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered "controls," though there are considerable uncertainties to this approach. Specifically, no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these "controls" the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the "control" means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a "no effect" distance at each site was considered the first distance greater than the maximum distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the "no effect" distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.e./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 1. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than only 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Weight of Evidence Conclusions

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of this field trial data is not suitable for the purpose of establishing an appropriate buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.e./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTII 1004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate and with the described nozzles restricting the droplet spectra extra-coarse and ultra-coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

2. Incidents

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in

place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (e.g. burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (e.g. leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EIIIS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. The air temperature and humidity at the time of dicamba application were reported to be 82°F and 55%, respectively. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8

µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements, as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty whether this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing. Further discussion of volatility is provided in **Section 3** below.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where "dicamba type" damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto's submitted information on the 73 incidents from 2012-2014 (discussed previously in this section). With the current information available, and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri). The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made.

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that were not followed included tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants, and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize since the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more likely impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory data conditions. Additional discussion and characterization of volatility is provided in the next section.

3. Volatility

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, because these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 lb a.e./A application rate and 220 feet for the 1.0 lb a.e./A application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However, consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the previous section (MO Case File #81513M00701, EHS Incident report number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (e.g. cooler temperatures)

4. Potential Effects on Terrestrial Plant Reproduction

EFED is aware of published literature associating dicamba applications with effects to soybean progeny. These studies indicate potential effects to the quantity and reproductive quality of future soybean generations following dicamba applications that would not be observed in the guideline vegetative vigor and seedling emergence studies EFED typically uses to assess risk to terrestrial plants. Therefore, these data raise a potential concern that has not been directly addressed in OPP assessments, should these effects occur at lower exposures than the effects observed in the guideline terrestrial plant studies. In meetings and email correspondence in January/February, 2015, OPP asked whether Monsanto was aware of this issue. Monsanto requested the references that OPP was aware of, so that they could independently review them.

Monsanto reviewed the open literature references provided by OPP and stated that none of the studies described effects on progeny at application rates lower than OPP's lowest available regulatory endpoint from the available vegetative vigor plant study (0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), therefore any mitigations (*i.e.* spray drift buffers) based on the plant height endpoint would be protective for effects to progeny.

The open literature studies examined seeds/pod, seed weight, seed quality, delayed maturation, pod malformation, reduced germination or progeny emergence, and malformed progeny. The vast majority of the studies did not investigate effects at rates as low as the NOAEC from the available vegetative vigor study. Monsanto's review of the available information indicated that the lowest effects endpoint reported from these studies was for delayed maturation of soybeans at rates as low as 0.56 g a.e./A from Kelley *et al.* (2005), which would still be almost 2 times less sensitive than the regulatory endpoint based on plant height that EFED has used in its risk assessments. Monsanto concluded that the open literature studies did not contain information that indicated that the in-field buffer based on plant height that is on the draft label would not also be protective of these reproductive effects.

EFED acknowledges Monsanto's submission of their analysis of the open literature data for effects to progeny, but to date has not independently reviewed each of these studies. However, for the following reason, EFED does not believe the information would change its risk assessments. The most sensitive endpoint reported in the open literature was a LOAEC of 0.56 g a.e./A for delayed maturation of soybeans (Kelley *et al.*, 2005; no NOAEC reported). As EFED's determination for risk to listed plant species is based on the most sensitive apical endpoint (*i.e.*, the NOAEC for soybean plant height from the available vegetative vigor study with dicamba DGA, 0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), less sensitive endpoints reported in the literature for effects to progeny would not impact EPA's risk assessments. EFED's policy regarding open literature is that typically if endpoints from the open literature are not more sensitive than guideline endpoints, then further analysis is not required (USEPA, 2011b)

5. Revised Terrestrial Vertebrate Endpoints

Parent Dicamba

The risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016, D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. The revised T-REX run presented in **Section 6** of this addendum reflects the adjusted chronic endpoint for parent dicamba.

Metabolite DCSA

Following preliminary review of a rat 2-generation study with DCSA (MRID 47899517), the risk assessment for the proposed new use on soybeans (USEPA, 2011 D378444) used a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016) was completed to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016) determined BMD₅ (estimated benchmark dose [BMD] to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised T-REX analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

6. Revised T-REX Analysis for Parent Dicamba and Quantitative Assessment of DCSA Exposure and Risk

Dicamba-specific Half-Life

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. However, EFED has refined this analysis by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application); a chemical-specific foliar dissipation half-life value for parent dicamba

(described below); and the new chronic mammalian endpoint for parent dicamba (described previously in **Section 5**).

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 2**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 2. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Parent Dicamba T-REX Analysis

Modeled maximum residue values (EECs) determined using this refined approach were slightly higher (~15%) than those determined in the original dicamba-tolerant soybean Section 3 assessment, but would not have impacted the screening-level risk conclusions for any assessed taxa. The previous risk assessment (2011) concluded that there was potential for direct adverse effects to mammals from chronic exposures of dicamba (max chronic RQ was 2.31 for small mammals consuming short grass). Following the refinements presented in this section (3 applications of dicamba to include the two post-emergent applications at the 0.5 lb a.e./A rate, foliar dissipation half-life decreased from 35 days to 8.4 days, and an increase in the mammalian chronic endpoint from 45 mg/kg-bw to 136 mg/kg-bw), there are no longer any exceedances for any size class of mammal consuming any dietary item (max RQ = 0.84, see **Appendix 1** for full T-REX input and output)

DCSA Metabolite Exposure Analysis

Since the chronic toxicity endpoints are more sensitive for DCSA than dicamba and DCSA residues were higher than dicamba residues within dicamba-tolerant soybean plant tissues (see below), EFED separately assessed the chronic exposure to DCSA residues for birds and mammals.

The available data indicate that DCSA has similar acute toxicity as parent dicamba, but is substantially more toxic on a chronic basis to mammals. In conventional soybean plants, DCSA residues following dicamba applications prior to planting were less than 2% of total dicamba residues in forage, hay and seed (MRIDs 43814101 and 44089307; max of 0.130 ppm DCSA, see **Appendix 2**) and would not be above toxicity thresholds for any taxa. However, in dicamba-tolerant soybean plants, dicamba is converted to DCSA and its glycosidic conjugates following demethylation of the aromatic methoxy moiety of dicamba (USEPA, 2013. HED residue chemistry summary) and in comparison to dicamba use on conventional soybeans, the maximum residues of DCSA in dicamba-tolerant soybean field trials following one 1-lb/A pre-emergent application and two 0.5-lb/A post-emergent applications were a substantially higher proportion of dicamba-related residues in forage, hay and seed (**Appendix 2** and MRID 47899524; 76%--88% of total dicamba-related residues). The empirical data from MRID 47899524 found means and maximums, respectively, of DCSA concentrations of 17.0 and 51.3 ppm, in forage 7-10 days following the last application, 32.2 and 61.1 ppm in hay 13-15 days following the last application and 0.059 and 0.440 ppm in seeds 73-98 days after the last application. EFED used the maximum measured values from the empirical data on forage, hay and seeds to assess risk to terrestrial vertebrates. There is some uncertainty in this approach as the maximum DCSA residues appear to be slightly increasing (16%) between forage at 7-10 days and hay at 13-15 days, however this could be due to the difference between fresher forage and drier hay, where DCSA has become more concentrated compared to the overall plant biomass, rather than due to additional conversion of dicamba residues to DCSA. Additionally, the amount of additional dicamba available to potentially convert to DCSA appears limited after this point as the maximum residues of dicamba were only 2.62 and 1.16 ppm in forage and hay, respectively.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-soybean and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization. This is because the conversion of dicamba to DCSA in plants is only expected to occur in crops modified to be tolerant to dicamba.

DCSA Effects Assessment

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds, resulting in a chronic avian endpoint of 40.9 mg/kg-bw. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who would not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into the egg during egg development).

Using the empirical dataset for DCSA residues in DT-soybean crops (as described above), the maximum residues in soybean forage and hay tissue were 61.1 ppm and in seeds were 0.440 ppm. Residues in arthropods (as a dietary item for birds and mammals consuming insects that

have consumed soybean tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications and therefore were considered to contain 42.5 ppm. This is likely conservative, given that the residues from the nomogram are for external residues in food items following a spray application while the actual exposures would be internal residue concentrations in the plant. A screening assessment using this empirical data for the exposure values results in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay tissue or consuming insects that had consumed soybean tissues with DCSA residues (RQs range from **1.1—3.3**, **Table 3**), for small birds consuming forage and hay tissue or insects that had fed on DT-soybean tissues, (RQs range from **1.2—1.7**, **Table 4**) and medium birds feeding on forage/hay tissue (marginal exceedance of **1.0**) but no exceedances occurred for any size mammalian or avian granivore consuming soybean grain (max granivore RQ of < 0.01).

Table 3. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-soybean tissues containing DCSA residues (maximum 61.1 mg/kg in forage/hay, 0.44 mg/kg in seeds) or consuming arthropods that had fed on DT-soybean tissues (assumed to contain 42.5 mg/kg DCSA). Bold RQ values exceed the LOC.

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Forage/Hay	0.0143	58.25	6.2	3.3
	Seed	0.00318	0.09	6.2	<0.01
	Arthropod	0.0143	40.52	6.2	2.3
Medium (35g)	Forage/Hay	0.0231	40.33	14.2	2.8
	Seed	0.00513	0.06	14.2	<0.01
	Arthropod	0.0231	28.05	14.2	2.0
Large (1000g)	Forage/Hay	0.153	9.35	17.6	1.5
	Seed	0.0340	0.01	17.6	<0.01
	Arthropod	0.153	6.50	17.6	1.1

Table 4. Dose-based exposure and risk quotients for birds consuming DT-soybean tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA for birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Forage/Hay	0.0228	69.65	40.9	1.7
	Seed	0.0051	0.11	40.9	<0.01
	Arthropod	0.0228	48.45	40.9	1.2
Medium (100g)	Forage/Hay	0.0649	39.65	40.9	1.0
	Seed	0.0144	0.06	40.9	<0.01
	Arthropod	0.0649	27.58	40.9	0.7
Large (1000g)	Forage/Hay	0.291	17.78	40.9	0.4
	Seed	0.065	0.03	40.9	<0.01
	Arthropod	0.291	12.37	40.9	0.3

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-soybean tissues (forage from days 7-10, hay from days 13-15 and seeds from

days 73-98) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-soybean plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure.

As noted above, EFED calculated these RQs based on the female lactation dose NOAEL endpoint of 8 mg/kg/d from the DCSA 2-generation study where reductions of up to 9% pup body weight were observed 2-3 weeks post birth at the next highest dose (78 mg/kg/d). If the BMDL₅ (the lower 95% confidence level on the estimated benchmark dose to result in a 5% body weight change in pups from background levels) of 34.9 mg/kg/d calculated by HED (EPA, 2016) for DCSA was used in place of the NOAEL, then the maximum residues from the empirical data in soybean hay would be below the threshold dose for all size classes of mammals feeding on soybean plant tissue or soybean-consuming arthropods (RQs would range from 0.35—0.76 for mammals feeding on tolerant soybean tissues and 0.24—0.53 for mammals feeding on arthropods having consumed soybean tissues).

7. Terrestrial Invertebrates Risk Characterization

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum¹ establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This addendum document explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial

¹ <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact $LD_{50} > 91 \mu\text{g a.e./bee}$ (MRID 00036935). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LD_{50} (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate ($1.0 \text{ lbs a.e./A} \times 2.7 \mu\text{g a.e./bee}$ (upper bound for contact exposures from a direct spray of 1 lb a.e./A , based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 ($2.7/91$) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral $LC_{50} > 100 \mu\text{g a.e./bee}$). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC_{50} (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of $32.12 \mu\text{g/bee/bee/day}$ ($1.0 \text{ lb a.e./A} \times 110 \mu\text{g a.e./g}$ {upper-bound residue for tall grass from T-REX} $\times 0.292 \text{ g/day}$ {pollen consumption rate}), the resultant RQ would be 0.32 ($32.12/100$) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may

² The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured. Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the soybean risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ³	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁴

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

³ Test material was dicamba BAPMA salt

⁴ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated contact-based bee chronic NOAEC of 38 µg a.e./bee. The acute dietary estimated exposure level for adult honeybees is 32.12 µg/bee/day for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 µg a.e./bee. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (*e.g.*, an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary

exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate developmental life stages and survival in organisms following prolonged exposure); and
2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the soybean risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning in summer, 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-soybean plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

8. *Runoff*

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). According to the original ecological risk assessment (USEPA, 2011a), dicamba is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 3** for calculations). Using these assumptions in TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 3**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

9. *Herbicide Interactions (Synergism)*

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba

and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent application (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans

Chemical Identity and Application Information				Application No.	Rate	Day of Application
Chemical Name:	Dicamba			1	1	0
Seed Treatment? (Check if yes)	<input type="checkbox"/>			2	0.5	7
Use:	cropcare			3	0.5	14
Product name and form:				4		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%			5		
Half-life (days):	8.4			6		
Are you assessing applications with variable rates or intervals?	yes			7		
Assessed Species Inputs (optional, use defaults for RQs for national level assessments)				8		
What body weight range is assessed (grams)?	Birds	Mammals		9		
Small	20	15		10		
Medium	100	35		11		
Large	1000	1000		12		
Reset Model				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		
				21		
				22		
				23		
				24		
				25		
				26		
				27		
				28		
				29		
				30		

The value in G6 must be zero

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	
LD50 (mg/kg-bw)	188.00	Subacute oral	
LC50 (mg/kg-diet)	10000.00	Subacute oral	
NOAEL (mg/kg-bw)		Subacute oral	
NOAEC (mg/kg-diet)	695.00	Mixed oral	
Enter the Mineau et al. Scaling Factor		1.15	
Mammalian			
Size (g) of mammal used in toxicity study	Acute Study		Chronic Study
Default rat body weight is 350 grams	350		350
Endpoint	Toxicity value	Reference (MRID)	
LD50 (mg/kg-bw)	2740.00		
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose	2720	mg/kg-diet based on standard FDA lab rat conversion	

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.87	4.16	0.03
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.39	2.37	0.01
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.12	1.06	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients

NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.0163	3.4819	0.0006
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.0139	2.4065	0.0005
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.0075	0.5579	0.0003

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.33	3.48	0.01
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.28	2.41	0.01
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.15	0.56	0.01

Appendix 2. Dicamba Crop Field Trial Residue Data Which Include the Determination of the DCSA Metabolite.

Table 1. Summary of Residues from Conventional Asparagus Crop Field Trials with DCSA as a Dicamba Residue of Concern.¹

Formulation ²	Total Application Rate (lb ae/A)	PHI (days)	N ³	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁵	HAFT ⁵	Median ⁵	Mean ⁵	SD ⁵
4 lb ae/gal DGA SL, 4 lb ae/gal DGA SL, and 2 lb ae/gal Na SL	Single post-emergence broadcast application of 0.5 lb ae/A	1	24	Parent	0.266	3.274	0.304	3.144	0.604	0.967	0.852
				DCSA ⁴	<0.01	0.071	<0.01	<0.040	0.011	0.014	0.0069
				Total	0.271	3.192	0.314	3.166	0.622	0.981	0.854

¹ Asparagus data are taken directly from MRID Nos. 43245206 and 43425803 (D204488, D204809, and D209229, L. Cheng, 07/14/1997) used for tolerance re-assessment in the 2005 RED.

² Test applications included the dimethylamine (DMA), diglycolamine (DGA), and sodium (Na⁺) salt formulations.

³ number of samples.

⁴ DCSA is the 3,6-dichloro-2-hydroxybenzoic acid metabolite.

⁵ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 2. Summary of Residues from Conventional Soybean Crop Field Trials (Seed) with DCSA as a Dicamba Residue of Concern.^{1,2}

Formulation ³	Total Application Rate (lb ae/A)	PHI (days)	N ⁴	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁶	HAFT ⁶	Median ⁶	Mean ⁶	SD ⁶
4 lb ae/gal DMA SL	Single 0.5 lb ae pre-plant treatment followed by a single post-emergence application of 2.0 lb ae/A	7	24	Parent	0.027	8.10	0.038	7.40	0.72	1.022	1.703
				DCSA ⁵	<0.01	0.130	<0.01	<0.048	.014	0.02	0.015
				5-OH dicamba	<0.01	0.360	<0.01	0.26	0.01	0.043	0.071
				Total	0.047	8.14	0.084	7.44	0.768	1.085	1.713

¹ Soybean grain data are for the 1X rate which used a 0.5 lb ae/A treatment made at 14-days pre-planting followed by a 2.0 lb ae/A treatment made at 7-days prior to harvest taken directly from MRID Nos. 43814101 (D223283, S. Knizner, 07/29/1996) and 44089307 (D228703, S. Chun, 07/16/1998) used for tolerance reassessment in the 2005 RED.

² The registrant was not supporting tolerances for soybean forage and hay at this time in lieu of a feeding restriction placed on the label. However, data were included for these commodities in the study submissions acquired using a single 0.5 lb ae/A treatment made at 14-days pre-planting (0.25x the maximum rate). Total residues of dicamba (parent, DCSA, and 5-OH dicamba) were <0.03 - <0.097 ppm in soybean forage and <0.03 - <0.04 ppm in soybean hay.

³ Test applications included the dimethylamine (DMA) salt formulation.

⁴ number of samples.

⁵ DCSA is the 3,6-dichloro-5-hydroxybenzoic acid metabolite.

⁶ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 3. Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

¹ Except for sample min/max, values reflect per trial averages; n = no. of field trials. For calculation of median, mean, and standard deviation, the LOQ (0.02 ppm each analyte in undelinted cotton seed and 0.04 ppm for each analyte in cotton gin byproducts) was used for any results reported as <LOQ in Table C.3. Combined residues of dicamba, 5-OH dicamba, DCSA, and DCSA are expressed in parent equivalents. Individual analyte results are reported as per se. N/A = Not applicable.

² LAFT = lowest-average-field-trial; HAFT = highest-average-field-trial.

Table 4. Summary of Residues from Dicamba-Tolerant Soybean Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Total Applic. Rate lb a.e./A (kg a.e./ha)	PHI (days)	Residue Levels ^{a, b} (ppm)						
			N	Min.	Max.	HAFT	Median (STMdR)	Mean (STMR)	Std. Dev.
DCGA ^c									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	0.356	5.90	5.27	1.93	2.02	1.02
Hay		13-15	44	0.167	7.26	7.19	2.00	2.66	1.91
Seed		73-98	44	<0.011	0.135	0.131	0.017	0.032	0.029
DCSA									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	8.92	51.3	50.4	15.0	17.0	8.00
Hay		13-15	44	12.2	61.1	60.7	31.9	32.2	11.2
Seed		73-98	44	0.010	0.440	0.439	0.033	0.059	0.089
Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	2.62	2.47	0.068	0.374	0.603
Hay		13-15	44	<LOQ	1.16	1.01	0.051	0.130	0.216
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
5-OH Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	0.009	0.009	0.005	0.006	<LOQ
Hay		13-15	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

^aConcentrations of the individual analytes are reported as dicamba equivalents

^bValues < LOQ are assumed to be at the LOQ.

^c DCGA residues were quantitated by a non-validated method

Appendix 3: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in **Table 1** for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure 1**. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in **Tables 2** and **3**.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%). In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40	105

°Lat	
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

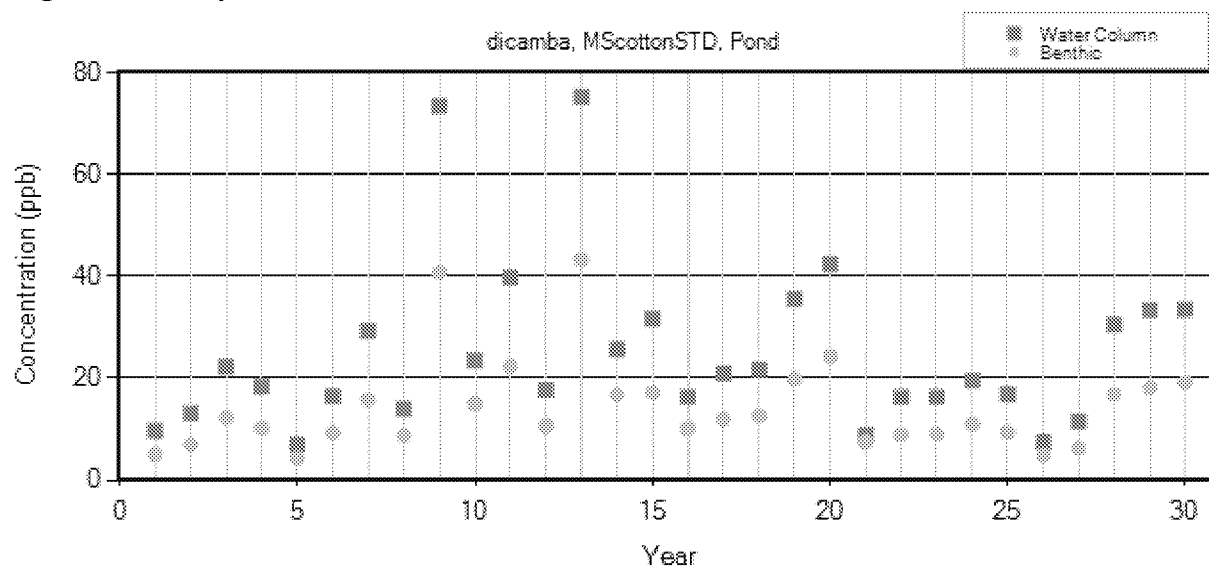


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (102,790 \text{ L water/ Acre-in}) * (1 \text{ inch}) * (1 \text{ lb/ } 453,592 \text{ mg})$
which reduces to:

Equation 2.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (0.226613)$

$EEC \text{ lb ai/A} = 0.061 \text{ mg/L} * 0.226613 = 0.0138$

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be $EEC \text{ lb ae/A} = 0.005 \text{ mg/L} * 0.226613 = 0.0011$. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e./A application rate and 0.06% loss through runoff and erosion.

Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

Jack Housenger, Director
Office of Pesticide Programs

Date: 3/31/16

Summary

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing to grant an unconditional registration under Section 3(c)(5) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba on genetically-modified dicamba-tolerant cotton and genetically-modified dicamba-tolerant soybean. The proposed new uses will be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582), containing 58.1% of the active ingredient dicamba, diglycolamine salt (DGA) for pre- and post-emergence (in-crop) applications to dicamba-tolerant cotton and soybean.

The U.S. Department of Agriculture (USDA) granted deregulation status for dicamba-tolerant cotton and soybean on January 15, 2015 under the Plant Protection Act.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Proposed Product: M1691 Herbicide

Background

On April 28, 2010 and July 30, 2012, respectively, EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on genetically-modified dicamba -tolerant soybean and cotton.

Dicamba is an active ingredient that is used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The proposed new uses on cotton and soybeans would expand the current timing of dicamba applications to dicamba-tolerant soybeans and cotton. Dicamba is currently registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. The proposed use would add post-emergence (over-the-top) applications to dicamba-tolerant cotton and soybean crops.

Dicamba is a member of the Benzoic acid family of herbicides (Herbicide Resistance Action Committee (HRAC) Group 4). Dicamba works by increasing plant growth rate. Once sufficient concentration is reached, the plant outgrows its own nutrient supplies and ultimately dies.

This proposal discusses several Agency considerations of the proposed use for dicamba on dicamba-tolerant soybeans and cotton, including discussions of human health and environmental risks associated with the proposed uses. Due to the multiple forms of dicamba, EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the

assessment for human health considered data associated with the BAPMA salt of dicamba, even though this registration action is being proposed for a formulation containing only the DGA salt of dicamba. This is because the data on the BAPMA salt was relevant to the analysis and resulted in the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. On the other hand, assessments focus on effects of the DGA salt when product specific considerations are discussed. For example, to determine appropriate spray drift buffers, the Agency examined drift potential using studies conducted on the DGA salt formulation.

Proposed New Uses

Cotton

On currently registered dicamba products for use on conventional cotton, pre-emergence treatment can be made at 8 fluid ounces (0.25 lb a.e. dicamba) per acre per season. The maximum single/annual application rate proposed for use on dicamba-tolerant cotton for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use, for post-emergence (in-crop) application of dicamba for use on dicamba-tolerant cotton, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in dicamba-tolerant cotton is 64 fluid ounces (2.0 lb a.e. dicamba) per acre.

If a preplant application of 32 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for dicamba-tolerant cotton.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest retreatment interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

On currently registered dicamba products, the maximum single and maximum annual application rate allowed to both conventional and dicamba-tolerant soybeans for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use for post-emergence (in-crop) application of this product to dicamba-tolerant soybeans, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in soybeans is 32 fluid ounces (1.0 lb a.e. dicamba) per acre.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay is 14 days (R1 Growth stage).

Evaluation

In evaluating a pesticide registration application, the EPA assesses a wide variety of information on the pesticide's toxicity (*i.e.*, effects on humans and other non-target organisms), exposure (*i.e.*, where and how the pesticide is used), and environmental fate (*i.e.*, how the chemical will move in the environment) to determine the likelihood of adverse effects (*i.e.*, risk) to human health and the environment resulting from the proposed uses. Risk assessments are developed to evaluate the environmental fate of the compound as well as how it might affect a wide range of non-target organisms including humans, terrestrial and aquatic wildlife and plants. On the basis of these assessments, EPA evaluates and approves language for each pesticide label to ensure the directions for use and safety measures are appropriate to mitigate any potential risk. The pesticide's label helps to communicate essential limitations and mitigations that are necessary for public safety. Once the risks are assessed and mitigation measures have been incorporated, EPA balances any remaining potential risks against the benefits of the use of the product. EPA will grant an application if it determines that the benefits of the use of the product outweigh its risks.

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human health risk assessment for dicamba, risks were assessed in a manner that assures human health protection to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba in registered or proposed to be registered products that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data showing greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency seen with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the Agency assumes that any amount of

exposure will lead to some degree of risk. Thus, the Agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be “not likely” to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2) more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment of dicamba. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The Agency determined, based on a reviews of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, EPA assumes that any amount of exposure will lead to some degree of risk. Thus, EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainty factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and 1X for FQPA SF when applicable). The inhalation HEC/HED results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) For dicamba, there is no

evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits.

After considering the available toxicity data, EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the Agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in

the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models. Therefore, the Agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other substances. For the purposes of this Proposed Registration Decision, therefore, EPA has assumed that dicamba does not have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities.

Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the point of departure for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and proposed uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the Agency's LOC for both food and water. For the U.S. population the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being proposed for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application inhalation exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the proposed uses of dicamba on dicamba-tolerant corn and soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. Volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40 acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Results of PERFUM modeling, however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates are not of concern.

4. Spray Drift

Spray drift is always a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The proposed maximum single application rate of dicamba is 1 lb ae/A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. For the purposes of the proposed uses on dicamba, this is considered a screening level assumption since the proposed use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate 1 lb ae/A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the FFDCA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- and long-term durations via the oral, dermal, and inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and proposed use sites. Drinking water values were incorporated directly into the assessment.

The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term aggregate risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short term aggregate risks.

6. Long-term aggregate risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

7. Occupational Risk Assessment

a. Short- and Intermediate-term handler Risk

EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on genetically -modified cotton and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short and Intermediate term Post-application Risk

EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard *via* the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation post application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The Agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the Agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the Agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on dicamba-tolerant soybean and cotton is provided below. More detailed discussions can be found in the Agency documents titled, *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708)* and *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)*, and its addendums entitled, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean and Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean*. These documents are in the docket. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water

and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would likely persist; however, EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. It may reach surface water via field/site runoff, spray drift during application, and by vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however EPA does not expect DCSA to reach groundwater at levels that would be of concern. The major route of exposure to non-target organisms is likely spray drift and runoff. Also, multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury. The assessments related to these routes of exposure are described in the sections below.

3. Runoff

The Agency has considered the potential effects due to runoff, and has developed proposed mitigation to limit off-site runoff. A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following dicamba applications, likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The Agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). EPA has also determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. Based on the weight of evidence approach, EPA determined that labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (*i.e.* NOAEC for soybean plant height).

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, the Agency had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Though the Agency found the information helpful, the submission did not include enough detail to verify the measurements in the studies. Therefore, in order to be protective of potential effects to non-target plants from volatilization, labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate. Although the Agency is not requiring additional data to be submitted at this time, if EPA receives volatility data under varied conditions of temperature and relative humidity, as these factors play a strong role in volatility under field conditions, it may reconsider whether this mitigation requirement is necessary.

EPA is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being proposed by EPA (400 feet as opposed to 110 to 220 feet). EPA has reviewed the information associated with the larger buffer in Arkansas to assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (*i.e.*, plant height) for the most sensitive plant species tested (*i.e.*, soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the proposed uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are

drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the proposed label. The Arkansas Plant Board felt that a 400 foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic ($RQ = \text{Exposure} / \text{Toxicity}$). RQs are then compared to EPA's levels of concern (LOCs). The LOCs are criteria used by the Agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the Agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including cotton and soybean. The proposed uses on dicamba-tolerant soybeans and cotton would expand the timing of applications from pre-emergence and pre-harvest only for soybeans and pre-emergence and post-harvest only for cotton to allowing post-emergence over-the-top applications. The maximum yearly application rates would remain 2.0 lb a.e./acre for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./acre between pre-emergence and post-emergence applications.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad

default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations.

The results of the screening level risk assessments indicate that the RQs do not exceed the Agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the Agency's LOC. The screening level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both cotton and soybeans, based on the proposed maximum application rates, the screening level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the Agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans. Before considering mitigation measures, EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening level assessment, further refinement, as discussed below, suggest that risks are lower.

1. Risk to Birds

For birds, the screening level assessment indicated that the RQs exceeded the Agency's LOCs on an acute basis for both soybean and cotton. More specifically, the screening level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in dicamba-tolerant soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming soybean forage/hay.

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The Agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs.

Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns, suggesting that dicamba consumed in the diet may possibly be less available than assumed using dose-based exposures. Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger concerns for many food items. In addition, estimates of exposure in screening level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms with territories established at distance from the field. With this last line of evidence in mind, the draft pesticide label requires an in-field 110 to 220-foot buffer to further reduce off-site exposure for birds (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for birds feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

2. Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the Agency's LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening level assessment using the maximum exposure values from empirical datasets for DCSA residues in dicamba-tolerant soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. A screening level assessment using the maximum exposure values from empirical data for DCSA residues in dicamba-tolerant cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the draft pesticide label requires an on-field 110 to 220-foot buffer in all directions to further reduce off-site exposure for mammals (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for mammals feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an Agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the proposed uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift, and for dicots in semi-aquatic areas due to runoff and spray drift. The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that labeling restrictions will help to reduce spray drift off field. The registrant submitted additional studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and the formulation in its application for registration. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1691 herbicide when an adequate buffer is incorporated between the application equipment and the edges of the treated field.

Additionally, to further mitigate against potential risks to plants from spray drift, the product labeling requires the use of 110-220 foot (depending on application rate) buffer between the last treated row and the closest edge of the field to be treated (in all directions). The Agency considered exposure to spray drift to be the principal risk issue associated with the proposed labeled use for all taxa. EPA considered a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting.

4. Synergism

EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. In EPA's risk assessments, the Agency uses GLP guideline studies to determine potential toxicity to plants, involving apical endpoints such as biomass and reproductive health. EPA believes this approach is very reliable for these purposes. However, at this time, the topic of synergy and multiple stressors is an uncertainty in assessing risk to non-target plants including endangered

species. Therefore, EPA is proposing a tank mix prohibition on the M1691 label to address this uncertainty.

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this proposed decision.

In the screening level risk assessment performed for the new application timing of dicamba (DGA) on genetically modified cotton and soybean to be tolerant to dicamba, EPA determined that direct concerns were unlikely (*i.e.* levels of concern were not exceeded) for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <https://www.epa.gov/endangered-species/ecological-risk-assessment-process-under-endangered-species-act>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still

exceeds the Agency's levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species' habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

This registration for dicamba is being proposed for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an assessment of listed species is completed for any such state.

Based on EPA's LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), EPA identified the listed species that are inside the "action area" (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 30 states.

The following criteria were used to assess listed species in the action area:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have "no effect."
- For listed individuals outside the action area, use of a pesticide would be determined to have "no effect."
- Listed individuals inside the action area may either fall into the "no effect" or "may effect" categories depending upon their specific biological needs and circumstances of exposure.

- Those that fall under the “may effect” category are found to be either “likely” or “not likely to be adversely affected.” This determination is made in consultation with the Services
- A “likely” or “not likely to adversely affect” determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift mitigation language including a 360 degree infield buffer (to varying length, depending on application rate) on the label is intended to limit off site transport of dicamba DGA through spray drift, as well as volatilization. Therefore, EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, EPA concluded a no effect determination for all but 24 species originally identified as potentially at-risk (in the screening level assessment) because they are not expected to occur on cotton and soybean fields. The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in EPA’s refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, EPA made a determination that exposure occurring on the field would have “may affects” (either “unlikely to adversely affect” or “likely to adversely affect” on 2 species (the Spring Creek Bladderpod and the Audubon Crested Caracara) in 2 counties (Wilson county, TN and Palm Beach county, FL, respectively) within the States covered by this proposed decision. Furthermore, the Agency has concluded that the 2 species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in both counties, thus mitigating any possible chance of exposure.

Additionally, the Agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, EPA’s analysis supports a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, EPA is proposing to require rainfast mitigation on the label (“Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.”) to protect against the risk of exposure to listed species off the treated field.

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on genetically-modified crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, EPA is proposing, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a

lack of performance can communicate directly with Monsanto by a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the proposed uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label. The registrant must then evaluate the situation to determine if lack of performance is caused by resistance or likely resistance.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy^[i], et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers’ permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15th, 2018, on or before January 15th of each year, Monsanto must submit annual summary reports to EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, county and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The

annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the proposed dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The Agency received 11 comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2010-0496) for the application to register the use of dicamba on genetically-modified soybeans and no comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2012-0841) for the application to register the use of dicamba on genetically-modified cotton. The majority of comments expressed concern (e.g., spray drift and volatilization) and requested that the Agency deny the proposed registration. The EPA welcomes input from the public during the decision process when registering pesticides, and is committed to thoroughly evaluating and mitigating any potential risks from registered pesticides, consistent with applicable statutory standards. EPA considered the public comments received in this regulatory decision.

The commenters focused on spray drift and volatilization concerns affecting non-target plants. The Agency has evaluated the risks regarding the potential drift of pesticides to sensitive crops and other non-target plants that may be adjacent to treatment areas. Specific label directions and restrictions have been proposed to protect from off-target movement of this pesticide product. Specifically, the proposed registration decision requires a 110-220 foot buffer between the treated area and edge of the field in all directions. These buffers are expected to keep spray drift from moving beyond the edge of the crop field to be treated as well as reduce the concern for volatility. In addition, the label will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide to distances within these buffers. The proposed regulatory decision also specifies that this product cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. Label language regarding spray volume, equipment ground speed, and spray boom height is intended to further protect against off-target drift. More details on EPA's and Monsanto's efforts to minimize effects to non-target plant species can be found in Section VIII.B.4 of this document.

Commenters also expressed concerns that weeds resistant to dicamba will become more prevalent as a result of this proposed use. Weed resistance is an increasing problem that has become a significant economic issue to growers. In an effort to address this concern and to prevent new weed resistance from happening, while giving growers another essential tool in their integrated pest management programs, Monsanto must put into place a stewardship program to promote responsible use of the proposed product in order to minimize the potential for increased

levels of weed resistance. This plan is discussed in detail in Section V and Section VIII.B.3 of this document.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Current registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the currently registered use of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba would expand weed management options on genetically-modified cotton and soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season would target new flushes of weeds, thereby reducing populations of these weeds and particularly would help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Proposed Registration Decision

In accordance with FIFRA, EPA only registers a pesticide when it can ensure that it will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, EPA is charged with balancing the uncertainties and risks posed by a pesticide against its benefits. EPA must determine if the benefits in light of its use outweigh the risks in order for the Agency to register a pesticide.

In the case for the proposed use of dicamba on dicamba-tolerant soybeans and cotton, and in consideration of all best available data and assessment methods, EPA believes this proposed decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. The Agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some levels of concern were exceeded for certain birds and mammals that may be in the fields that would be treated. The Agency notes that these are very conservative risk estimates using screening level (worst case) assumptions, and that they most likely do not apply to the majority of the birds and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated

field. Because of these additional restrictions, EPA expects the proposed uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the Agency's levels of concern.

On the benefits side of the analysis, use of dicamba on dicamba-tolerant soybeans and cotton is expected become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of U.S. soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states stretching across the southern half of the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on dicamba-tolerant soybeans and cotton would be beneficial as it provides an effective tool to treat especially noxious weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba could help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to soybean and cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the proposed labeling restrictions will include protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

After weighing all the risks of concern against the benefits of the proposed uses, EPA finds that when the proposed mitigation measures are applied, the risks that may remain are minimal, if they exist at all, while the benefits are potentially great. Therefore, the benefits outweigh the risks and registering these uses will not generally cause unreasonable adverse effects on human health or the environment during the 5-year time limited registration being proposed (a 5-year registration is proposed so that any unexpected weed resistance issues that may result from the proposed uses can be addressed before granting an extension or EPA can allow the registration to terminate if necessary). EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(5) registration finding for the proposed uses.

A. Data Requirements

There are no outstanding data requirements required to support the registration of this action. However, data may be required in connection with registration review activities for dicamba. Those requirements would be generic to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the proposed supplemental labels unless otherwise noted below.

1. **Worker Protection** *(Although the following Worker Protection labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. **Environmental Hazards** *(Although the following Environmental Hazards labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1691™ for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call XXXXXXXX.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless in conjunction with another mode of action herbicide with overlapping spectrum.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use the Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying M1691 Herbicide. Do not use any other nozzle and pressure combination not specifically allowed by this label.

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and are impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical

air mixing. The inversion will dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

a. Buffer

Maintain a 110-foot buffer (when applying 16 fl oz of this product per acre), or a 220-foot buffer (when applying 32 fl oz of this product per acre) between the treated area and the edge of the field in all directions.

b. Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1691 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1691 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.

- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans.
- The combined total application rate from crop emergence up to 7 days pre-harvest must not exceed 64 fluid ounce (2.0lb a.e dicamba) per acre for cotton.
- All applications for both cotton and soybeans must not exceed 64 fluid ounces (2.0 lb a.e dicamba) per acre.

C. Registration Terms

EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. EPA is basing the proposed registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

Monsanto must have an Herbicide Resistance Management (HRM) Plan for M1691 Herbicide developed and approved by EPA before a final registration can be issued. The HRM Plan must focus on educating growers on the appropriate use of the M1691 Herbicide and the associated dicamba-tolerant seeds. EPA is requiring that the HRM Plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

Monsanto or its representative must investigate reports of lack of herbicide efficacy as reported by users following “scouting.” When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for “likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Additionally, Monsanto must collect material, if possible, for further testing. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if

requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures.

c. Annual Reporting of Herbicide Resistance to EPA

Monsanto must submit annual summary reports to EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, county and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

2. EPA's Continued Control over the Registration

Because the issue of weed resistance is an extremely important issue to keep under control and can be very fast moving, this registration will expire 5 years from the date of the registration issuance, unless this term is removed or modified by EPA. At the end of 5 years, EPA can work to address any unexpected weed resistance issues that may result from the proposed uses before granting an extension or allow the registration to terminate if necessary.

3. Geographic Limitation on Use of Dicamba M1691 Herbicide

EPA is proposing to issue this registration only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62.
<http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/7/2016 11:02:57 PM
To: Rowland, Grant [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=5b004bc79f1f40b0a181a584a8c64495-Rowland, Grant]; Baris, Reuben [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a0181e3f02a246fc915a4af026e249fc-Baris, Reuben]; Schmid, Emily [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0c06b35a5f814370b9a92d394f969332-Hartman, Emily]; Kenny, Daniel [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1be9bb592f144269bcd41dd3a6d8a6d4-Daniel C. Kenny]; Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
BCC: DCRoomPYS7621B/Potomac-Yard-One [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=user9413b74]
Subject: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; EFED original RA - Dicamba Soybean.pdf; Dicamba Soybean EFED addendum #1.pdf; Dicamba Soybean Addendum #2 (includes drift, volate, incidence).docx; Dicamba_ESA Phase 1 3-3-16_CLEANmlk_bjw-03-07-16.docx; Dicamba Phase 2 States ESA Assessment_12-10-15.docx; Phase 3+4 States ESA Assessment_12-10-15.docx; Dicamba Cotton RA (includes drift, volate, incidence (draft).docx
Location: DCRoomPYS7621B/Potomac-Yard-One
Start: 3/9/2016 6:00:00 PM
End: 3/9/2016 7:00:00 PM
Show Time As: Busy



Final Registration
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EFED original RA -
Dicamba Soybea...



Dicamba Soybean
EFED addendum...



Dicamba Soybean
Addendum #2 (i...



Dicamba_ESA
Phase 1 3-3-16_...



Dicamba Cotton
RA (includes drif...



Dicamba Phase 2
States ESA Asse...



Phase 3+4 States
ESA Assessmen...



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

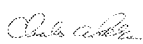
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Elizabeth Donovan
DN: cn=Elizabeth Donovan, o=EPA, ou=EFED,
email=donovan.elizabeth@epa.gov, c=US
Date: 2014.05.20 08:29:33 -04'00'
Digitally signed by Baris, Reuben
DN: cn=Baris, Reuben,
email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Mark Corbin
DN: cn=Mark Corbin, o=USEPA, ou=EFED,
email=corbin.mark@epa.gov, c=US
Date: 2014.05.20 12:42:48 -04'00'

REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 $\mu\text{g}/\text{m}^3$ less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 $\mu\text{g}/\text{m}^3$ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (ERIM) 3-8-11
Michael Wagman 3/8/11

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

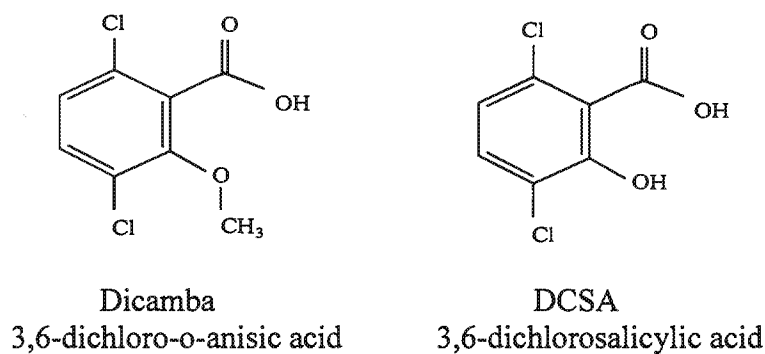
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		

¹- M1691 Herbicide

²- Registered uses

³- "Acid equivalent"

⁴- Calculated by dividing the max application rate by the max individual application rate.

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

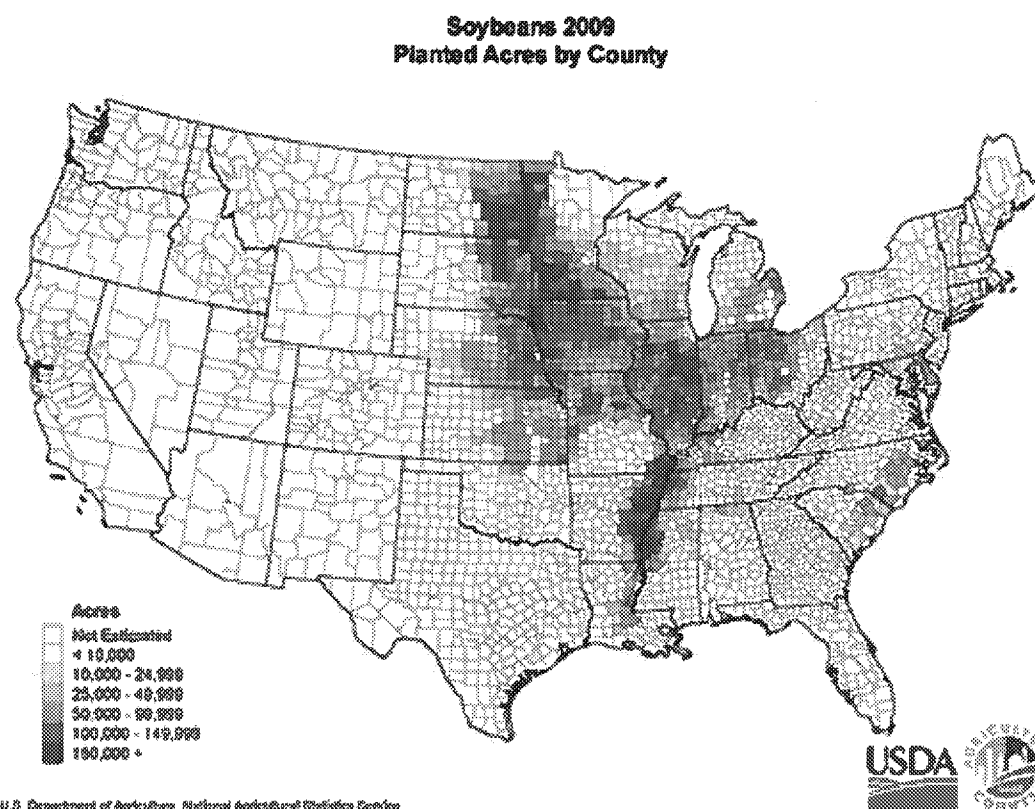


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

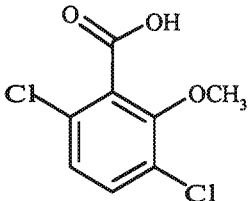
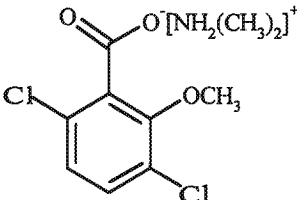
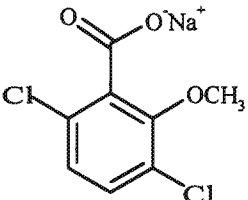
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

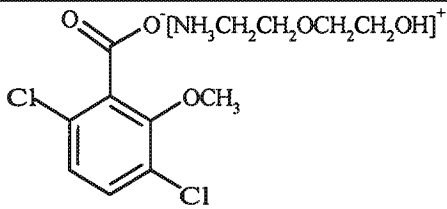
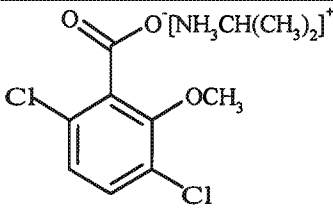
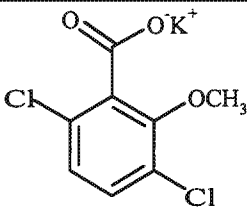
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	$C_{12}H_{17}Cl_2NO_5$
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	$C_{11}H_{15}Cl_2NO_3$
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	$C_8H_5Cl_2KO_3$
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mm/yy	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA
 IPSCND 1
 UPTKF
 Record 18: PLVKRT
 PLDKRT
 FEXTRC 0.5
 Flag for Index Res. Run IR EPA Pond
 Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mmm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/9/2016 8:20:55 PM
To: Baris, Reuben [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a0181e3f02a246fc915a4af026e249fc-Baris, Reuben]; Schmid, Emily [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0c06b35a5f814370b9a92d394f969332-Hartman, Emily]; Kenny, Daniel [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1be9bb592f144269bcd41dd3a6d8a6d4-Daniel C. Kenny]; Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
BCC: DCRoomPYS7621B/Potomac-Yard-One [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=user9413b74]
Subject: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; EFED original RA - Dicamba Soybean.pdf; Dicamba Soybean EFED addendum #1.pdf; Dicamba Soybean Addendum #2 (includes drift, volate, incidence).docx; Dicamba_ESA Phase 1 3-3-16_CLEANmlk_bjw-03-07-16.docx; Dicamba Phase 2 States ESA Assessment_12-10-15.docx; Phase 3+4 States ESA Assessment_12-10-15.docx; Dicamba Cotton RA (includes drift, volate, incidence (draft).docx
Location: DCRoomPYS7621B/Potomac-Yard-One
Start: 3/9/2016 6:00:00 PM
End: 3/9/2016 7:00:00 PM
Show Time As: Tentative



Final Registration
of Enlist Duo Her...



EFED original RA -
Dicamba Soybea...



Dicamba Soybean
EFED addendum...



Dicamba Soybean
Addendum #2 (i...



Dicamba_ESA
Phase 1 3-3-16_...



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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

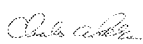
TO: Kathryn Montague, Risk Manager (RM 23)
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Environmental Fate and Effects Division (7507P)

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Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 ug/m³ less than the air concentration required to exceed the EC₂₅ (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 µg/m²•s⁻¹, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 ug/m³ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC₂₅). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC₂₅ at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Teske, M.E., Bird, S.L., Esterly, D.M., Ray, S.L., Perry, S.G. 2001. A User's Guide for AgDRIFT[®] 2.01: A Tiered Approach for the Assessment of Spray Drift of Pesticides (*Regulatory Version*). Spray Drift Task Force, Macon, MS. CDI Report No. 01-02.

USEPA 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA530-R-05-006. United States Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

USEPA 2013. Data Evaluation Report for EPA MRID No. 49135901. ARCADIS. 2010. Generation of Empirical Curves for Spray Drift Data. Report prepared by ARCADIS U.S. Inc., Chelmsford, MA, sponsored and submitted by CropLife America, Washington, DC; 62 pages. Final report issued June 2, 2010.

Woodrow, J., Seiber, J., Baker, L. 1997. *Correlation Techniques for Estimating Pesticide Volatilization Flux and Downwind Concentrations*. Environ. Sci. Technol., 31:523-529

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (GrIM) 3-8-11
Michael Wagman 3/8/11

Michael Corbin 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

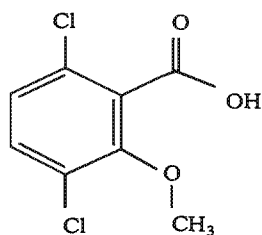
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

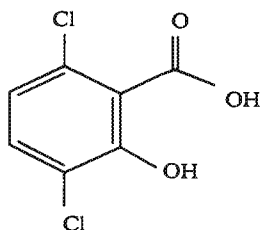
SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



Dicamba
3,6-dichloro-o-anisic acid



DCSA
3,6-dichlorosalicylic acid

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		

¹- M1691 Herbicide

²- Registered uses

³- "Acid equivalent"

⁴- Calculated by dividing the max application rate by the max individual application rate.

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

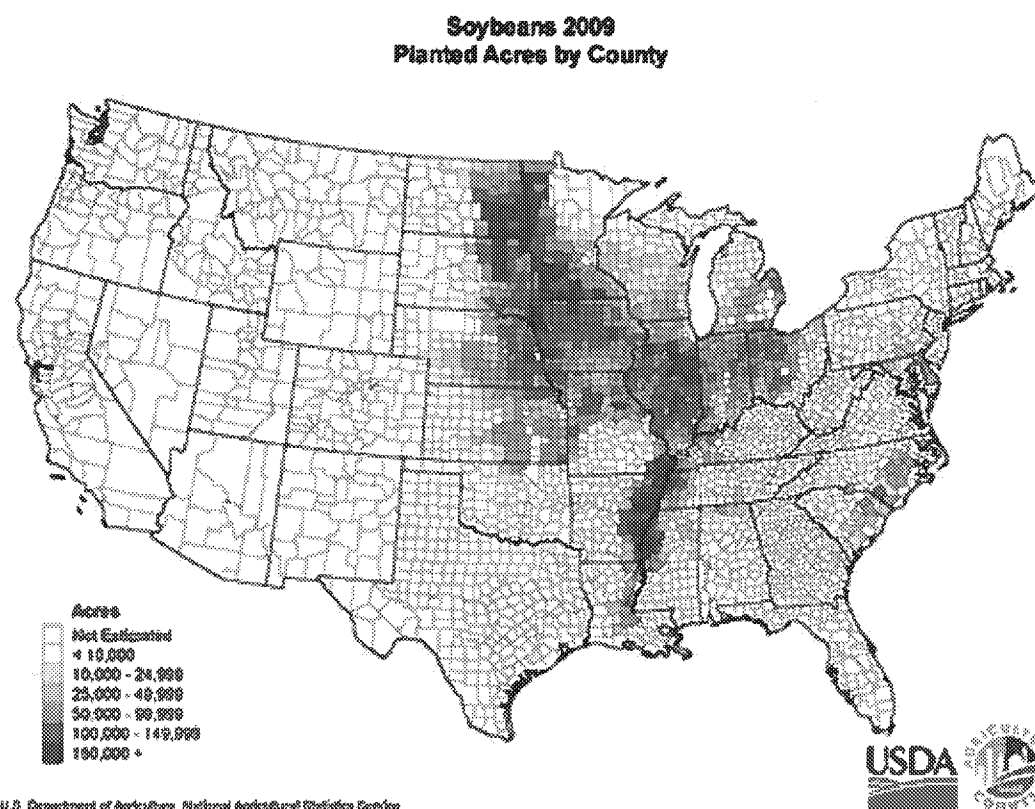


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see Table 8). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

References:

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APPENDIX I

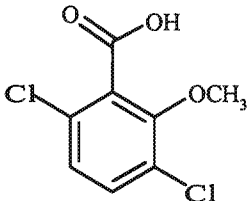
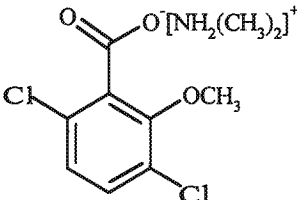
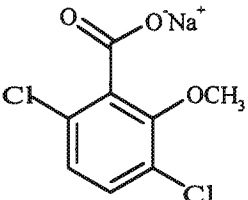
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

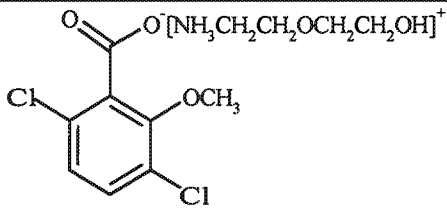
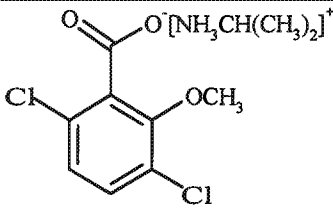
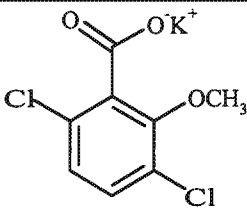
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
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Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mmm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/9/2016 5:11:34 PM
To: Baris, Reuben [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a0181e3f02a246fc915a4af026e249fc-Baris, Reuben]; Schmid, Emily [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0c06b35a5f814370b9a92d394f969332-Hartman, Emily]; Kenny, Daniel [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1be9bb592f144269bcd41dd3a6d8a6d4-Daniel C. Kenny]; Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
BCC: DCRoomPYS7621B/Potomac-Yard-One [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=user9413b74]
Subject: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; EFED original RA - Dicamba Soybean.pdf; Dicamba Soybean EFED addendum #1.pdf; Dicamba Soybean Addendum #2 (includes drift, volate, incidence).docx; Dicamba Cotton RA (includes drift, volate, incidence (draft).docx; Dicamba_ESA Phase 1 3-3-16_CLEANmlk_bjw-03-07-16.docx; Dicamba Phase 2 States ESA Assessment_12-10-15.docx; Phase 3+4 States ESA Assessment_12-10-15.docx
Location: DCRoomPYS7621B/Potomac-Yard-One
Start: 3/9/2016 6:00:00 PM
End: 3/9/2016 7:00:00 PM
Show Time As: Tentative



Final Registration
of Enlist Duo Her...



EFED original RA -
Dicamba Soybea...



Dicamba Soybean
EFED addendum...



Dicamba Soybean
Addendum #2 (i...



Dicamba Cotton
RA (includes drif...



Dicamba_ESA
Phase 1 3-3-16_...



Dicamba Phase 2
States ESA Asse...



Phase 3+4 States
ESA Assessmen...



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

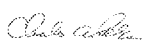
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Elizabeth Donovan
DN: cn=Elizabeth Donovan, o=EPA, ou=EFED,
email=donovan.elizabeth@epa.gov, c=US
Date: 2014.05.20 08:29:33 -04'00'
Digitally signed by Baris, Reuben
DN: cn=Baris, Reuben,
email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Mark Corbin
DN: cn=Mark Corbin, o=USEPA, ou=EFED,
email=corbin.mark@epa.gov, c=US
Date: 2014.05.20 12:42:48 -04'00'

REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 $\mu\text{g}/\text{m}^3$ less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 $\mu\text{g}/\text{m}^3$ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (GrIM) 3-8-11
Michael Wagman 3/8/11

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

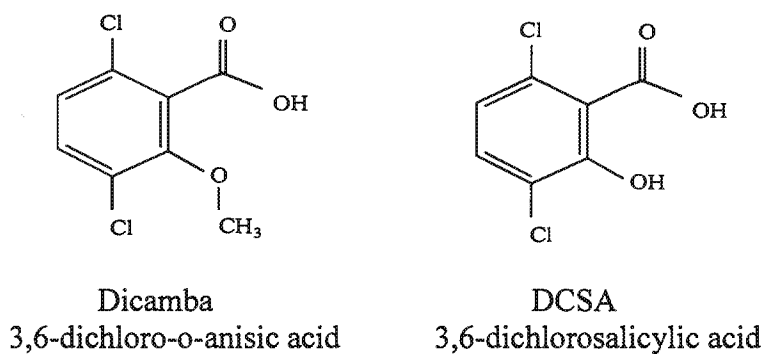
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		

¹- M1691 Herbicide

²- Registered uses

³- "Acid equivalent"

⁴- Calculated by dividing the max application rate by the max individual application rate.

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

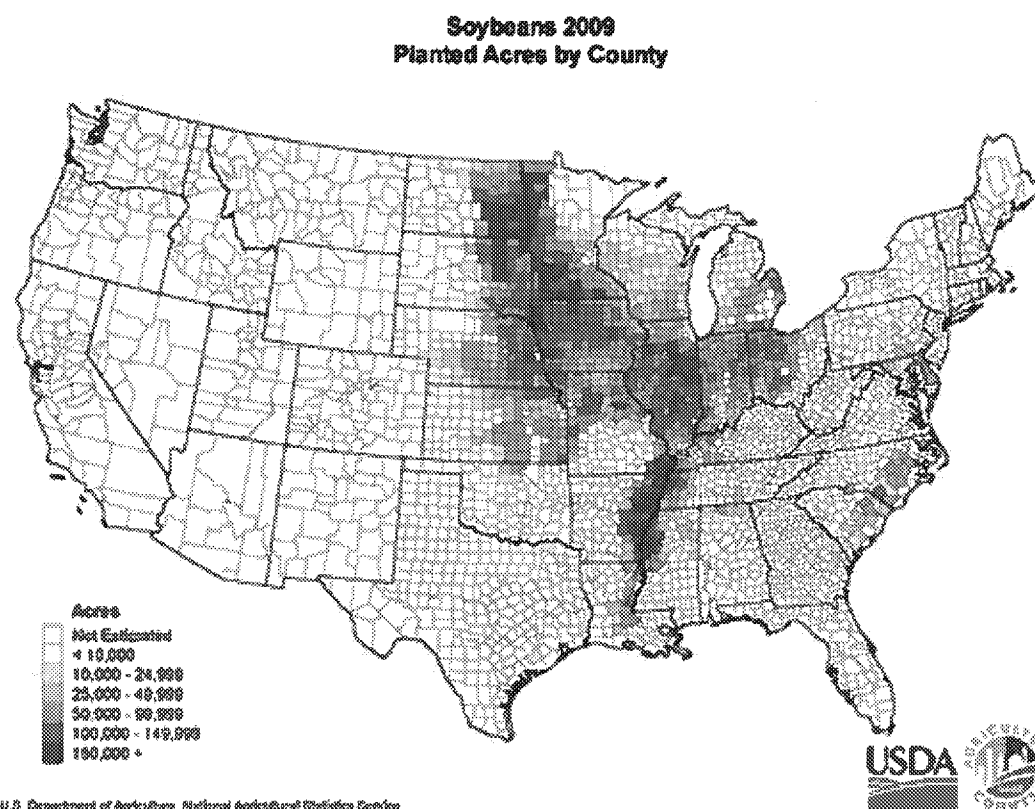


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

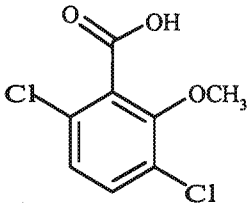
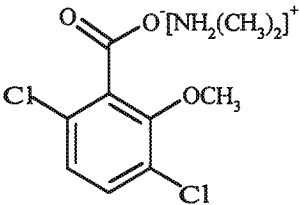
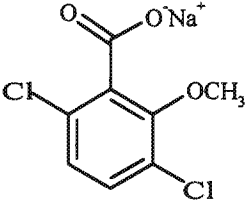
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

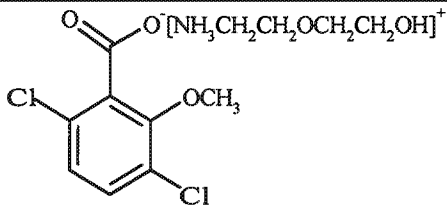
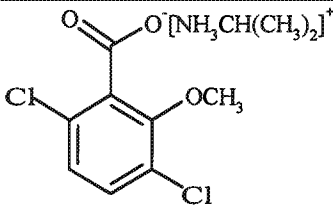
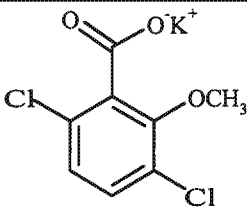
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies						
Degradate	Max Degradate Concentration (% of applied)					
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)
DCGA					3.64% in soil/water system	
5-OH-Dicamba				0.8%	1.9% in soil/water system	
2,5-DiOH-Dicamba				2.7%		
						present
						not detected
						not detected
						not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
-------------	---------------	-------	-------	----------

Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mm/yy	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSSoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mmm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/8/2016 3:57:41 PM
To: Baris, Reuben [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a0181e3f02a246fc915a4af026e249fc-Baris, Reuben]; Schmid, Emily [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0c06b35a5f814370b9a92d394f969332-Hartman, Emily]
BCC: DCRoomPYS7621B/Potomac-Yard-One [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=user9413b74]
Subject: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; Dicamba Cotton RA (draft).docx; EFED original RA - Dicamba Soybean.pdf; Dicamba EFED addendum #1.pdf; 128931_416416+_ESA Phase 1 Assessment_3-3-16_CLEANmlk_bjw-03-07-16.docx
Location: DCRoomPYS7621B/Potomac-Yard-One
Start: 3/9/2016 6:00:00 PM
End: 3/9/2016 7:00:00 PM
Show Time As: Tentative



Final Registration
of Enlist Duo Her...



Dicamba Cotton
RA (draft).docx



EFED original RA -
Dicamba Soybea...



Dicamba EFED
addendum #1.pdf



128931_416416+...
Phase 1 Assess...



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

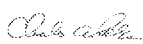
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Elizabeth Donovan
DN: cn=Elizabeth Donovan, o=EPA, ou=EFED,
email=donovan.elizabeth@epa.gov, c=US
Date: 2014.05.20 08:29:33 -04'00'
Digitally signed by Baris, Reuben
DN: cn=Baris, Reuben,
email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Mark Corbin
DN: cn=Mark Corbin, o=USEPA, ou=EFED,
email=corbin.mark@epa.gov, c=US
Date: 2014.05.20 12:42:48 -04'00'

REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is > 91 $\mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of >711 $\mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is 162.85 $\mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2 \cdot \text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 ug/m³ less than the air concentration required to exceed the EC₂₅ (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 µg/m²•s⁻¹, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 ug/m³ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC₂₅). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC₂₅ at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (GrIM) 3-8-11
Michael Wagman 3/8/11

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

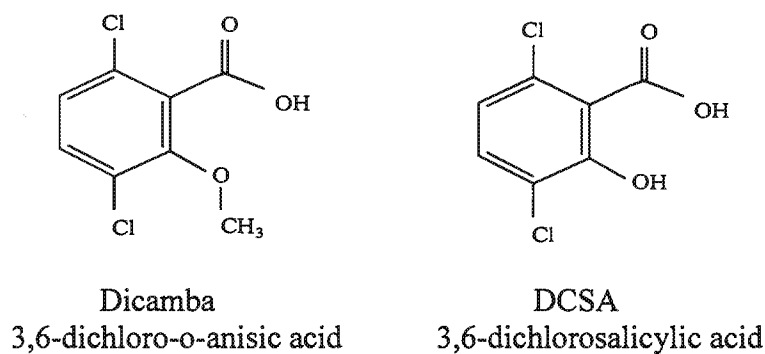
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		
¹ - M1691 Herbicide ² - Registered uses ³ - "Acid equivalent" ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

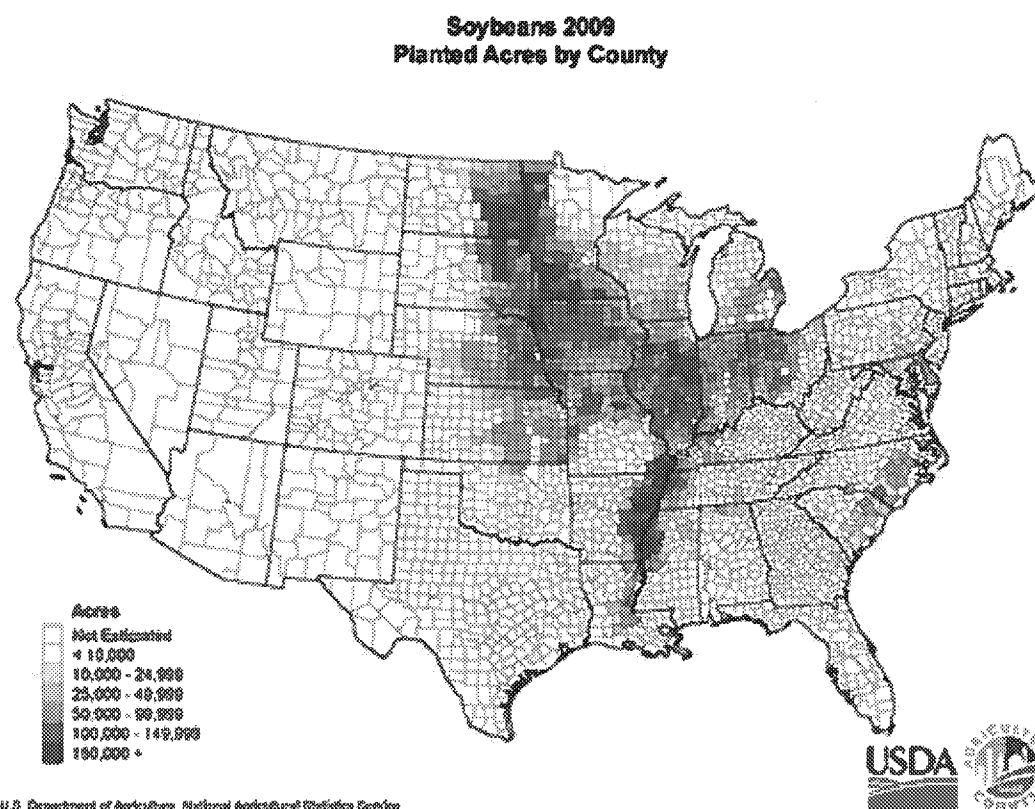


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

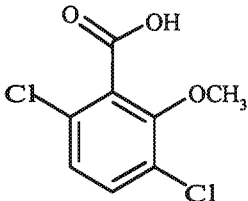
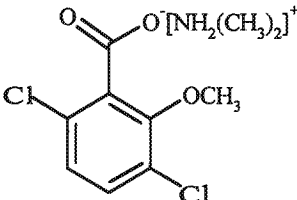
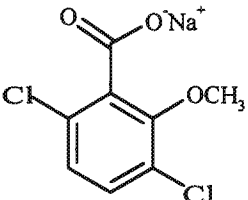
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

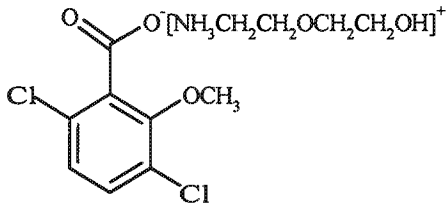
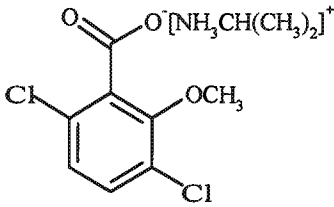
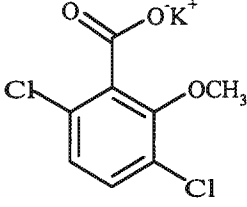
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
-------------	---------------	-------	-------	----------

Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mm/yy	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214

0.1 2.3788 2.2615 1.958 1.5565 1.3295 0.69082
Average of yearly averages: 0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSSoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/8/2016 3:57:03 PM
BCC: DCRoomPYS7771D/Potomac-Yard-One [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=user360df7c]
Subject: Canceled: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; Dicamba Cotton RA (draft).docx; EFED original RA - Dicamba Soybean.pdf; Dicamba EFED addendum #1.pdf; 128931_416416+_ESA Phase 1 Assessment_3-3-16_CLEANmlk_bjw-03-07-16.docx
Location: DCRoomPYS7621B/Potomac-Yard-One
Start: 3/9/2016 6:00:00 PM
End: 3/9/2016 7:00:00 PM
Show Time As: Free
Importance: High



Final Registration
of Enlist Duo Her...



Dicamba Cotton
RA (draft).docx



EFED original RA -
Dicamba Soybea...



Dicamba EFED
addendum #1.pdf



128931_416416+...
Phase 1 Assess...



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

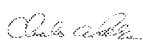
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

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Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ...etc

concentration from AERSCREEN at the edge of the field is 283 $\mu\text{g}/\text{m}^3$ less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 $\mu\text{g}/\text{m}^3$ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (RM 23) 3-8-11
Michael Wagman 3/8/11

Michael Corbin 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

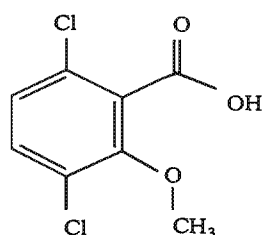
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

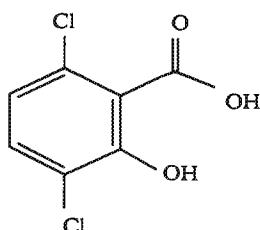
SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



Dicamba
3,6-dichloro-o-anisic acid



DCSA
3,6-dichlorosalicylic acid

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		
¹ - M1691 Herbicide ² - Registered uses ³ - "Acid equivalent" ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

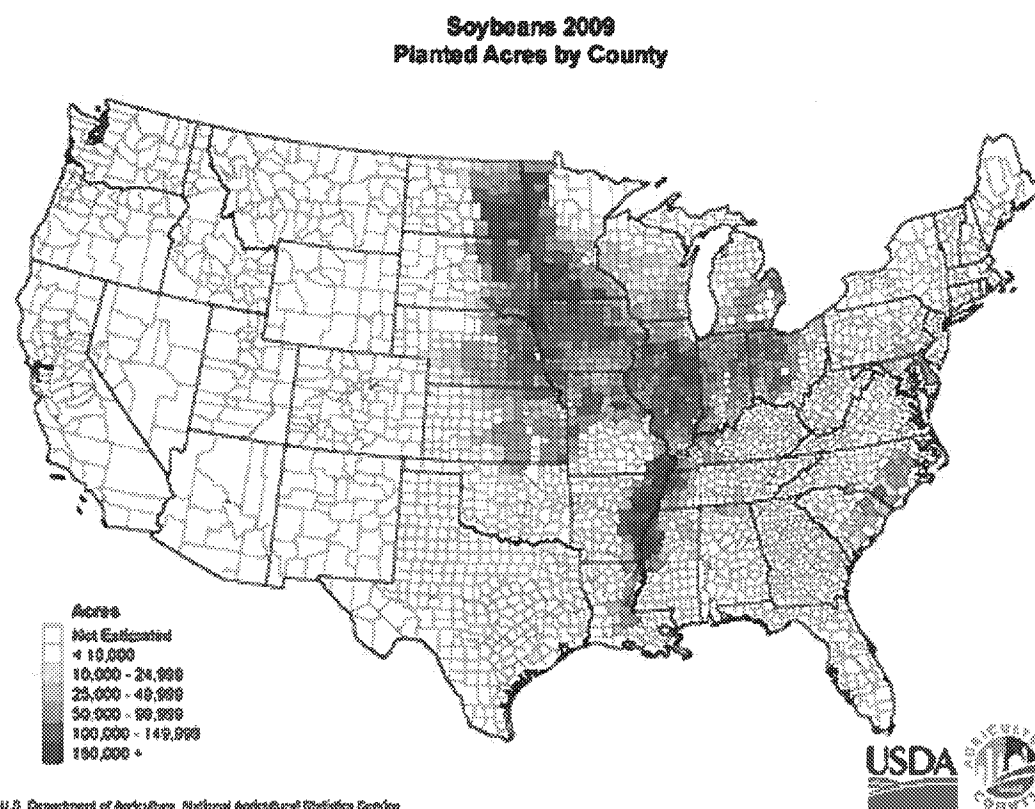


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

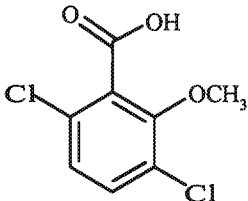
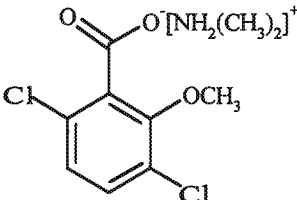
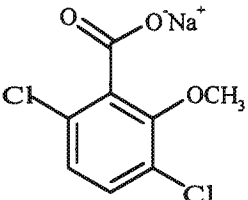
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	$C_{12}H_{17}Cl_2NO_5$
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	$C_{11}H_{15}Cl_2NO_3$
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	$C_8H_5Cl_2KO_3$
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.977
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
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Molecular weight	mw	221	g/mol	
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Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
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Vapor Pressure	vapr	3.41E-5	torr	
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Solubility	sol	6100	mg/L	
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Kd	Kd		mg/L	
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Koc	Koc	13.4	mg/L	
-----	-----	------	------	--

Photolysis half-life	kdp	105	days	Half-life
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Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
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Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
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Aerobic Soil Metabolism	asm	18	days	Halfife
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Hydrolysis:	pH 5	0	days	Half-life
-------------	------	---	------	-----------

Hydrolysis:	pH 7	0	days	Half-life
-------------	------	---	------	-----------

Hydrolysis:	pH 9	0	days	Half-life
-------------	------	---	------	-----------

Method:	CAM	2	integer	See PRZM manual
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Incorporation Depth:	DEPI		cm	
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Application Rate:	TAPP	1.12	kg/ha	
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Application Efficiency:	APPEFF	0.99	fraction	
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Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
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Application Date	Date	16-04	dd/mm or dd/mm/mm or dd-mm or dd-mm/mm	
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Interval 1 interval	3	days	Set to 0 or delete line for single app.	
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app. rate 1 apprate	0.56	kg/ha		
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Interval 2 interval	3	days	Set to 0 or delete line for single app.	
---------------------	---	------	---	--

app. rate 2 apprate	0.56	kg/ha		
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Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run	IR	EPA Pond
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Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)
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Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSSoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/8/2016 2:47:45 PM
To: Baris, Reuben [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a0181e3f02a246fc915a4af026e249fc-Baris, Reuben]; Schmid, Emily [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0c06b35a5f814370b9a92d394f969332-Hartman, Emily]
BCC: DCRoomPYS7771D/Potomac-Yard-One [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=user360df7c]
Subject: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; Dicamba Cotton RA (draft).docx; EFED original RA - Dicamba Soybean.pdf; Dicamba EFED addendum #1.pdf; 128931_416416+_ESA Phase 1 Assessment_3-3-16_CLEANmlk_bjw-03-07-16.docx
Location: DCRoomPYS7771D/Potomac-Yard-One
Start: 3/8/2016 7:00:00 PM
End: 3/8/2016 8:00:00 PM
Show Time As: Tentative



Final Registration
of Enlist Duo Her...



Dicamba Cotton
RA (draft).docx



EFED original RA -
Dicamba Soybea...



Dicamba EFED
addendum #1.pdf



128931_416416+...
Phase 1 Assess...



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

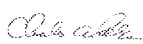
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Elizabeth Donovan
DN: cn=Elizabeth Donovan, o=EPA, ou=EFED,
email=donovan.elizabeth@epa.gov, c=US
Date: 2014.05.20 08:29:33 -04'00'
Digitally signed by Baris, Reuben
DN: cn=Baris, Reuben,
email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Mark Corbin
DN: cn=Mark Corbin, o=USEPA, ou=EFED,
email=corbin.mark@epa.gov, c=US
Date: 2014.05.20 12:42:48 -04'00'

REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'

Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 $\mu\text{g}/\text{m}^3$ less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 $\mu\text{g}/\text{m}^3$ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (ERIM) 3-8-11
Michael Wagman 3/8/11

Michael Corbin 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

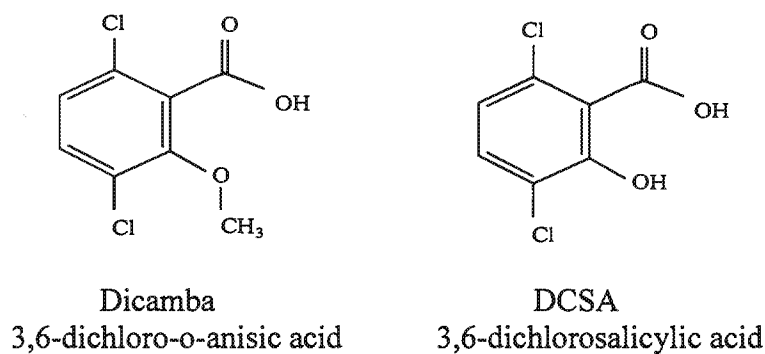
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		

¹- M1691 Herbicide

²- Registered uses

³- "Acid equivalent"

⁴- Calculated by dividing the max application rate by the max individual application rate.

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

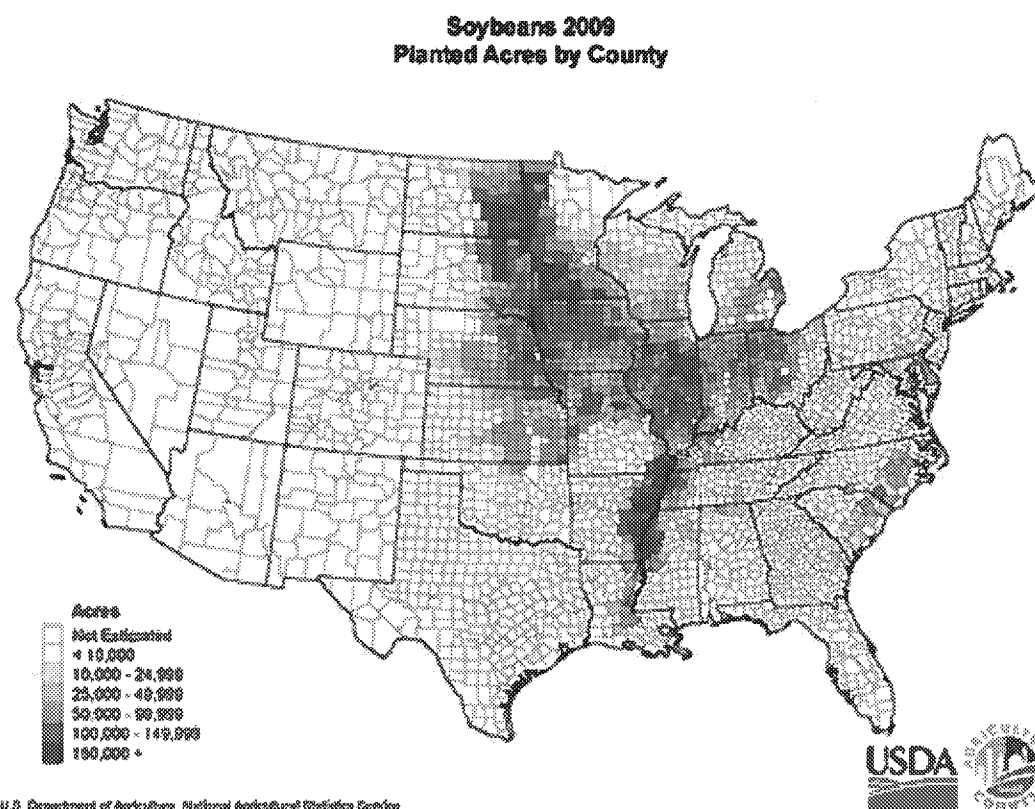


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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Weidenhamer, J.D., G.B. Triplett, and F.E. Sobotka. 1989. Dicamba injury to soybean. Agronomy Journal. Vol. 81: 637-643.

APPENDIX I

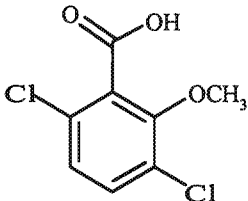
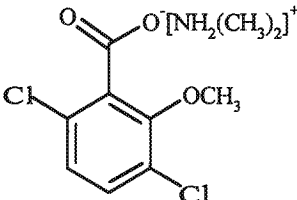
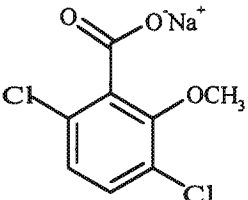
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

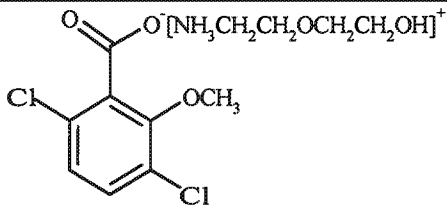
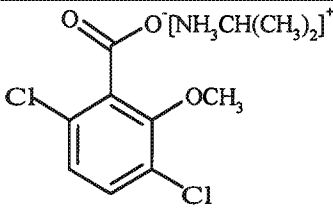
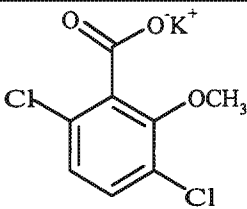
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
-------------	---------------	-------	-------	----------

Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSSoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.



Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

Jack Housenger, Director
Office of Pesticide Programs

Date: 3/31/16

Summary

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing to grant an unconditional registration under Section 3(c)(5) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba on genetically-modified dicamba-tolerant cotton and genetically-modified dicamba-tolerant soybean. The proposed new uses will be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582), containing 58.1% of the active ingredient dicamba, diglycolamine salt (DGA) for pre- and post-emergence (in-crop) applications to dicamba-tolerant cotton and soybean.

The U.S. Department of Agriculture (USDA) granted deregulation status for dicamba-tolerant cotton and soybean on January 15, 2015 under the Plant Protection Act.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Proposed Product: M1691 Herbicide

Background

On April 28, 2010 and July 30, 2012, respectively, EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on genetically-modified dicamba -tolerant soybean and cotton.

Dicamba is an active ingredient that is used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The proposed new uses on cotton and soybeans would expand the current timing of dicamba applications to dicamba-tolerant soybeans and cotton. Dicamba is currently registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. The proposed use would add post-emergence (over-the-top) applications to dicamba-tolerant cotton and soybean crops.

Dicamba is a member of the Benzoic acid family of herbicides (Herbicide Resistance Action Committee (HRAC) Group 4). Dicamba works by increasing plant growth rate. Once sufficient concentration is reached, the plant outgrows its own nutrient supplies and ultimately dies.

This proposal discusses several Agency considerations of the proposed use for dicamba on dicamba-tolerant soybeans and cotton, including discussions of human health and environmental risks associated with the proposed uses. Due to the multiple forms of dicamba, EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the

assessment for human health considered data associated with the BAPMA salt of dicamba, even though this registration action is being proposed for a formulation containing only the DGA salt of dicamba. This is because the data on the BAPMA salt was relevant to the analysis and resulted in the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. On the other hand, assessments focus on effects of the DGA salt when product specific considerations are discussed. For example, to determine appropriate spray drift buffers, the Agency examined drift potential using studies conducted on the DGA salt formulation.

Proposed New Uses

Cotton

On currently registered dicamba products for use on conventional cotton, pre-emergence treatment can be made at 8 fluid ounces (0.25 lb a.e. dicamba) per acre per season. The maximum single/annual application rate proposed for use on dicamba-tolerant cotton for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use, for post-emergence (in-crop) application of dicamba for use on dicamba-tolerant cotton, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in dicamba-tolerant cotton is 64 fluid ounces (2.0 lb a.e. dicamba) per acre.

If a preplant application of 32 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for dicamba-tolerant cotton.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest retreatment interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

On currently registered dicamba products, the maximum single and maximum annual application rate allowed to both conventional and dicamba-tolerant soybeans for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use for post-emergence (in-crop) application of this product to dicamba-tolerant soybeans, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in soybeans is 32 fluid ounces (1.0 lb a.e. dicamba) per acre.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay is 14 days (R1 Growth stage).

Evaluation

In evaluating a pesticide registration application, the EPA assesses a wide variety of information on the pesticide's toxicity (*i.e.*, effects on humans and other non-target organisms), exposure (*i.e.*, where and how the pesticide is used), and environmental fate (*i.e.*, how the chemical will move in the environment) to determine the likelihood of adverse effects (*i.e.*, risk) to human health and the environment resulting from the proposed uses. Risk assessments are developed to evaluate the environmental fate of the compound as well as how it might affect a wide range of non-target organisms including humans, terrestrial and aquatic wildlife and plants. On the basis of these assessments, EPA evaluates and approves language for each pesticide label to ensure the directions for use and safety measures are appropriate to mitigate any potential risk. The pesticide's label helps to communicate essential limitations and mitigations that are necessary for public safety. Once the risks are assessed and mitigation measures have been incorporated, EPA balances any remaining potential risks against the benefits of the use of the product. EPA will grant an application if it determines that the benefits of the use of the product outweigh its risks.

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human health risk assessment for dicamba, risks were assessed in a manner that assures human health protection to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba in registered or proposed to be registered products that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data showing greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency seen with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the Agency assumes that any amount of

exposure will lead to some degree of risk. Thus, the Agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be “not likely” to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2) more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment of dicamba. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The Agency determined, based on a reviews of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, EPA assumes that any amount of exposure will lead to some degree of risk. Thus, EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainty factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and 1X for FQPA SF when applicable). The inhalation HEC/HED results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) For dicamba, there is no

evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits.

After considering the available toxicity data, EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the Agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in

the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models. Therefore, the Agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other substances. For the purposes of this Proposed Registration Decision, therefore, EPA has assumed that dicamba does not have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities.

Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the point of departure for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and proposed uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the Agency's LOC for both food and water. For the U.S. population the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being proposed for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application inhalation exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the proposed uses of dicamba on dicamba-tolerant corn and soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. Volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40 acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Results of PERFUM modeling, however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates are not of concern.

4. Spray Drift

Spray drift is always a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The proposed maximum single application rate of dicamba is 1 lb ae/A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. For the purposes of the proposed uses on dicamba, this is considered a screening level assumption since the proposed use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate 1 lb ae/A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the FFDCA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- and long-term durations via the oral, dermal, and inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and proposed use sites. Drinking water values were incorporated directly into the assessment.

The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term aggregate risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short term aggregate risks.

6. Long-term aggregate risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

7. Occupational Risk Assessment

a. Short- and Intermediate-term handler Risk

EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on genetically -modified cotton and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short and Intermediate term Post-application Risk

EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard *via* the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation post application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The Agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the Agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the Agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on dicamba-tolerant soybean and cotton is provided below. More detailed discussions can be found in the Agency documents titled, *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708)* and *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)*, and its addendums entitled, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean and Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean*. These documents are in the docket. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water

and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would likely persist; however, EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. It may reach surface water via field/site runoff, spray drift during application, and by vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however EPA does not expect DCSA to reach groundwater at levels that would be of concern. The major route of exposure to non-target organisms is likely spray drift and runoff. Also, multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury. The assessments related to these routes of exposure are described in the sections below.

3. Runoff

The Agency has considered the potential effects due to runoff, and has developed proposed mitigation to limit off-site runoff. A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following dicamba applications, likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The Agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). EPA has also determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. Based on the weight of evidence approach, EPA determined that labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (*i.e.* NOAEC for soybean plant height).

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, the Agency had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Though the Agency found the information helpful, the submission did not include enough detail to verify the measurements in the studies. Therefore, in order to be protective of potential effects to non-target plants from volatilization, labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate. Although the Agency is not requiring additional data to be submitted at this time, if EPA receives volatility data under varied conditions of temperature and relative humidity, as these factors play a strong role in volatility under field conditions, it may reconsider whether this mitigation requirement is necessary.

EPA is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being proposed by EPA (400 feet as opposed to 110 to 220 feet). EPA has reviewed the information associated with the larger buffer in Arkansas to assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (*i.e.*, plant height) for the most sensitive plant species tested (*i.e.*, soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the proposed uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are

drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the proposed label. The Arkansas Plant Board felt that a 400 foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic ($RQ = \text{Exposure} / \text{Toxicity}$). RQs are then compared to EPA's levels of concern (LOCs). The LOCs are criteria used by the Agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the Agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including cotton and soybean. The proposed uses on dicamba-tolerant soybeans and cotton would expand the timing of applications from pre-emergence and pre-harvest only for soybeans and pre-emergence and post-harvest only for cotton to allowing post-emergence over-the-top applications. The maximum yearly application rates would remain 2.0 lb a.e./acre for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./acre between pre-emergence and post-emergence applications.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad

default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations.

The results of the screening level risk assessments indicate that the RQs do not exceed the Agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the Agency's LOC. The screening level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both cotton and soybeans, based on the proposed maximum application rates, the screening level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the Agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans. Before considering mitigation measures, EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening level assessment, further refinement, as discussed below, suggest that risks are lower.

1. Risk to Birds

For birds, the screening level assessment indicated that the RQs exceeded the Agency's LOCs on an acute basis for both soybean and cotton. More specifically, the screening level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in dicamba-tolerant soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming soybean forage/hay.

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The Agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs.

Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns, suggesting that dicamba consumed in the diet may possibly be less available than assumed using dose-based exposures. Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger concerns for many food items. In addition, estimates of exposure in screening level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms with territories established at distance from the field. With this last line of evidence in mind, the draft pesticide label requires an in-field 110 to 220-foot buffer to further reduce off-site exposure for birds (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for birds feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

2. Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the Agency's LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening level assessment using the maximum exposure values from empirical datasets for DCSA residues in dicamba-tolerant soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. A screening level assessment using the maximum exposure values from empirical data for DCSA residues in dicamba-tolerant cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the draft pesticide label requires an on-field 110 to 220-foot buffer in all directions to further reduce off-site exposure for mammals (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for mammals feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an Agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the proposed uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift, and for dicots in semi-aquatic areas due to runoff and spray drift. The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that labeling restrictions will help to reduce spray drift off field. The registrant submitted additional studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and the formulation in its application for registration. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1691 herbicide when an adequate buffer is incorporated between the application equipment and the edges of the treated field.

Additionally, to further mitigate against potential risks to plants from spray drift, the product labeling requires the use of 110-220 foot (depending on application rate) buffer between the last treated row and the closest edge of the field to be treated (in all directions). The Agency considered exposure to spray drift to be the principal risk issue associated with the proposed labeled use for all taxa. EPA considered a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting.

4. Synergism

EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. In EPA's risk assessments, the Agency uses GLP guideline studies to determine potential toxicity to plants, involving apical endpoints such as biomass and reproductive health. EPA believes this approach is very reliable for these purposes. However, at this time, the topic of synergy and multiple stressors is an uncertainty in assessing risk to non-target plants including endangered

species. Therefore, EPA is proposing a tank mix prohibition on the M1691 label to address this uncertainty.

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this proposed decision.

In the screening level risk assessment performed for the new application timing of dicamba (DGA) on genetically modified cotton and soybean to be tolerant to dicamba, EPA determined that direct concerns were unlikely (*i.e.* levels of concern were not exceeded) for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <https://www.epa.gov/endangered-species/ecological-risk-assessment-process-under-endangered-species-act>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still

exceeds the Agency's levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species' habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

This registration for dicamba is being proposed for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an assessment of listed species is completed for any such state.

Based on EPA's LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), EPA identified the listed species that are inside the "action area" (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 30 states.

The following criteria were used to assess listed species in the action area:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have "no effect."
- For listed individuals outside the action area, use of a pesticide would be determined to have "no effect."
- Listed individuals inside the action area may either fall into the "no effect" or "may effect" categories depending upon their specific biological needs and circumstances of exposure.

- Those that fall under the “may effect” category are found to be either “likely” or “not likely to be adversely affected.” This determination is made in consultation with the Services
- A “likely” or “not likely to adversely affect” determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift mitigation language including a 360 degree infield buffer (to varying length, depending on application rate) on the label is intended to limit off site transport of dicamba DGA through spray drift, as well as volatilization. Therefore, EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, EPA concluded a no effect determination for all but 24 species originally identified as potentially at-risk (in the screening level assessment) because they are not expected to occur on cotton and soybean fields. The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in EPA’s refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, EPA made a determination that exposure occurring on the field would have “may affects” (either “unlikely to adversely affect” or “likely to adversely affect” on 2 species (the Spring Creek Bladderpod and the Audubon Crested Caracara) in 2 counties (Wilson county, TN and Palm Beach county, FL, respectively) within the States covered by this proposed decision. Furthermore, the Agency has concluded that the 2 species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in both counties, thus mitigating any possible chance of exposure.

Additionally, the Agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, EPA’s analysis supports a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, EPA is proposing to require rainfast mitigation on the label (“Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.”) to protect against the risk of exposure to listed species off the treated field.

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on genetically-modified crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, EPA is proposing, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a

lack of performance can communicate directly with Monsanto by a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the proposed uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label. The registrant must then evaluate the situation to determine if lack of performance is caused by resistance or likely resistance.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy^[i], et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers’ permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15th, 2018, on or before January 15th of each year, Monsanto must submit annual summary reports to EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, county and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The

annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the proposed dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The Agency received 11 comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2010-0496) for the application to register the use of dicamba on genetically-modified soybeans and no comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2012-0841) for the application to register the use of dicamba on genetically-modified cotton. The majority of comments expressed concern (e.g., spray drift and volatilization) and requested that the Agency deny the proposed registration. The EPA welcomes input from the public during the decision process when registering pesticides, and is committed to thoroughly evaluating and mitigating any potential risks from registered pesticides, consistent with applicable statutory standards. EPA considered the public comments received in this regulatory decision.

The commenters focused on spray drift and volatilization concerns affecting non-target plants. The Agency has evaluated the risks regarding the potential drift of pesticides to sensitive crops and other non-target plants that may be adjacent to treatment areas. Specific label directions and restrictions have been proposed to protect from off-target movement of this pesticide product. Specifically, the proposed registration decision requires a 110-220 foot buffer between the treated area and edge of the field in all directions. These buffers are expected to keep spray drift from moving beyond the edge of the crop field to be treated as well as reduce the concern for volatility. In addition, the label will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide to distances within these buffers. The proposed regulatory decision also specifies that this product cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. Label language regarding spray volume, equipment ground speed, and spray boom height is intended to further protect against off-target drift. More details on EPA's and Monsanto's efforts to minimize effects to non-target plant species can be found in Section VIII.B.4 of this document.

Commenters also expressed concerns that weeds resistant to dicamba will become more prevalent as a result of this proposed use. Weed resistance is an increasing problem that has become a significant economic issue to growers. In an effort to address this concern and to prevent new weed resistance from happening, while giving growers another essential tool in their integrated pest management programs, Monsanto must put into place a stewardship program to promote responsible use of the proposed product in order to minimize the potential for increased

levels of weed resistance. This plan is discussed in detail in Section V and Section VIII.B.3 of this document.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Current registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the currently registered use of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba would expand weed management options on genetically-modified cotton and soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season would target new flushes of weeds, thereby reducing populations of these weeds and particularly would help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Proposed Registration Decision

In accordance with FIFRA, EPA only registers a pesticide when it can ensure that it will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, EPA is charged with balancing the uncertainties and risks posed by a pesticide against its benefits. EPA must determine if the benefits in light of its use outweigh the risks in order for the Agency to register a pesticide.

In the case for the proposed use of dicamba on dicamba-tolerant soybeans and cotton, and in consideration of all best available data and assessment methods, EPA believes this proposed decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. The Agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some levels of concern were exceeded for certain birds and mammals that may be in the fields that would be treated. The Agency notes that these are very conservative risk estimates using screening level (worst case) assumptions, and that they most likely do not apply to the majority of the birds and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated

field. Because of these additional restrictions, EPA expects the proposed uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the Agency's levels of concern.

On the benefits side of the analysis, use of dicamba on dicamba-tolerant soybeans and cotton is expected become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of U.S. soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states stretching across the southern half of the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on dicamba-tolerant soybeans and cotton would be beneficial as it provides an effective tool to treat especially noxious weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba could help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to soybean and cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the proposed labeling restrictions will include protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

After weighing all the risks of concern against the benefits of the proposed uses, EPA finds that when the proposed mitigation measures are applied, the risks that may remain are minimal, if they exist at all, while the benefits are potentially great. Therefore, the benefits outweigh the risks and registering these uses will not generally cause unreasonable adverse effects on human health or the environment during the 5-year time limited registration being proposed (a 5-year registration is proposed so that any unexpected weed resistance issues that may result from the proposed uses can be addressed before granting an extension or EPA can allow the registration to terminate if necessary). EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(5) registration finding for the proposed uses.

A. Data Requirements

There are no outstanding data requirements required to support the registration of this action. However, data may be required in connection with registration review activities for dicamba. Those requirements would be generic to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the proposed supplemental labels unless otherwise noted below.

- 1. Worker Protection** *(Although the following Worker Protection labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

- 2. Environmental Hazards** *(Although the following Environmental Hazards labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1691™ for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call XXXXXXXX.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless in conjunction with another mode of action herbicide with overlapping spectrum.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use the Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying M1691 Herbicide. Do not use any other nozzle and pressure combination not specifically allowed by this label.

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and are impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical

air mixing. The inversion will dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

a. Buffer

Maintain a 110-foot buffer (when applying 16 fl oz of this product per acre), or a 220-foot buffer (when applying 32 fl oz of this product per acre) between the treated area and the edge of the field in all directions.

b. Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1691 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1691 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.

- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans.
- The combined total application rate from crop emergence up to 7 days pre-harvest must not exceed 64 fluid ounce (2.0lb a.e dicamba) per acre for cotton.
- All applications for both cotton and soybeans must not exceed 64 fluid ounces (2.0 lb a.e dicamba) per acre.

C. Registration Terms

EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. EPA is basing the proposed registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

Monsanto must have an Herbicide Resistance Management (HRM) Plan for M1691 Herbicide developed and approved by EPA before a final registration can be issued. The HRM Plan must focus on educating growers on the appropriate use of the M1691 Herbicide and the associated dicamba-tolerant seeds. EPA is requiring that the HRM Plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

Monsanto or its representative must investigate reports of lack of herbicide efficacy as reported by users following “scouting.” When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for “likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Additionally, Monsanto must collect material, if possible, for further testing. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if

requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures.

c. Annual Reporting of Herbicide Resistance to EPA

Monsanto must submit annual summary reports to EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, county and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

2. EPA's Continued Control over the Registration

Because the issue of weed resistance is an extremely important issue to keep under control and can be very fast moving, this registration will expire 5 years from the date of the registration issuance, unless this term is removed or modified by EPA. At the end of 5 years, EPA can work to address any unexpected weed resistance issues that may result from the proposed uses before granting an extension or allow the registration to terminate if necessary.

3. Geographic Limitation on Use of Dicamba M1691 Herbicide

EPA is proposing to issue this registration only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62.
<http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 5/9/2017 8:38:43 PM
To: Samek, Karen [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=30f9d5f5f09f46eb8edfcaa0ad69c746-Karen Samek]
Subject: dicamba documents
Attachments: Dicamba response to comments.pdf; dicamba proposed decision.pdf

*Grant Rowland
Herbicide Branch
Registration Division
Office of Pesticide Programs
703-347-0254*



Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

Jack Housenger, Director
Office of Pesticide Programs

Date: 3/31/16

Summary

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing to grant an unconditional registration under Section 3(c)(5) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba on genetically-modified dicamba-tolerant cotton and genetically-modified dicamba-tolerant soybean. The proposed new uses will be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582), containing 58.1% of the active ingredient dicamba, diglycolamine salt (DGA) for pre- and post-emergence (in-crop) applications to dicamba-tolerant cotton and soybean.

The U.S. Department of Agriculture (USDA) granted deregulation status for dicamba-tolerant cotton and soybean on January 15, 2015 under the Plant Protection Act.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Proposed Product: M1691 Herbicide

Background

On April 28, 2010 and July 30, 2012, respectively, EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on genetically-modified dicamba -tolerant soybean and cotton.

Dicamba is an active ingredient that is used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The proposed new uses on cotton and soybeans would expand the current timing of dicamba applications to dicamba-tolerant soybeans and cotton. Dicamba is currently registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. The proposed use would add post-emergence (over-the-top) applications to dicamba-tolerant cotton and soybean crops.

Dicamba is a member of the Benzoic acid family of herbicides (Herbicide Resistance Action Committee (HRAC) Group 4). Dicamba works by increasing plant growth rate. Once sufficient concentration is reached, the plant outgrows its own nutrient supplies and ultimately dies.

This proposal discusses several Agency considerations of the proposed use for dicamba on dicamba-tolerant soybeans and cotton, including discussions of human health and environmental risks associated with the proposed uses. Due to the multiple forms of dicamba, EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the

assessment for human health considered data associated with the BAPMA salt of dicamba, even though this registration action is being proposed for a formulation containing only the DGA salt of dicamba. This is because the data on the BAPMA salt was relevant to the analysis and resulted in the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. On the other hand, assessments focus on effects of the DGA salt when product specific considerations are discussed. For example, to determine appropriate spray drift buffers, the Agency examined drift potential using studies conducted on the DGA salt formulation.

Proposed New Uses

Cotton

On currently registered dicamba products for use on conventional cotton, pre-emergence treatment can be made at 8 fluid ounces (0.25 lb a.e. dicamba) per acre per season. The maximum single/annual application rate proposed for use on dicamba-tolerant cotton for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use, for post-emergence (in-crop) application of dicamba for use on dicamba-tolerant cotton, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in dicamba-tolerant cotton is 64 fluid ounces (2.0 lb a.e. dicamba) per acre.

If a preplant application of 32 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for dicamba-tolerant cotton.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest retreatment interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

On currently registered dicamba products, the maximum single and maximum annual application rate allowed to both conventional and dicamba-tolerant soybeans for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use for post-emergence (in-crop) application of this product to dicamba-tolerant soybeans, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in soybeans is 32 fluid ounces (1.0 lb a.e. dicamba) per acre.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay is 14 days (R1 Growth stage).

Evaluation

In evaluating a pesticide registration application, the EPA assesses a wide variety of information on the pesticide's toxicity (*i.e.*, effects on humans and other non-target organisms), exposure (*i.e.*, where and how the pesticide is used), and environmental fate (*i.e.*, how the chemical will move in the environment) to determine the likelihood of adverse effects (*i.e.*, risk) to human health and the environment resulting from the proposed uses. Risk assessments are developed to evaluate the environmental fate of the compound as well as how it might affect a wide range of non-target organisms including humans, terrestrial and aquatic wildlife and plants. On the basis of these assessments, EPA evaluates and approves language for each pesticide label to ensure the directions for use and safety measures are appropriate to mitigate any potential risk. The pesticide's label helps to communicate essential limitations and mitigations that are necessary for public safety. Once the risks are assessed and mitigation measures have been incorporated, EPA balances any remaining potential risks against the benefits of the use of the product. EPA will grant an application if it determines that the benefits of the use of the product outweigh its risks.

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human health risk assessment for dicamba, risks were assessed in a manner that assures human health protection to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba in registered or proposed to be registered products that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data showing greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency seen with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the Agency assumes that any amount of

exposure will lead to some degree of risk. Thus, the Agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be “not likely” to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2) more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment of dicamba. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The Agency determined, based on a reviews of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, EPA assumes that any amount of exposure will lead to some degree of risk. Thus, EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainty factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and 1X for FQPA SF when applicable). The inhalation HEC/HED results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) For dicamba, there is no

evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits.

After considering the available toxicity data, EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the Agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in

the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models. Therefore, the Agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other substances. For the purposes of this Proposed Registration Decision, therefore, EPA has assumed that dicamba does not have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities.

Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the point of departure for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and proposed uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the Agency's LOC for both food and water. For the U.S. population the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being proposed for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application inhalation exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the proposed uses of dicamba on dicamba-tolerant corn and soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. Volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40 acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Results of PERFUM modeling, however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates are not of concern.

4. Spray Drift

Spray drift is always a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The proposed maximum single application rate of dicamba is 1 lb ae/A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. For the purposes of the proposed uses on dicamba, this is considered a screening level assumption since the proposed use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate 1 lb ae/A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the FFDCA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- and long-term durations via the oral, dermal, and inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and proposed use sites. Drinking water values were incorporated directly into the assessment.

The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term aggregate risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short term aggregate risks.

6. Long-term aggregate risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

7. Occupational Risk Assessment

a. Short- and Intermediate-term handler Risk

EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on genetically -modified cotton and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short and Intermediate term Post-application Risk

EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard *via* the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation post application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The Agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the Agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the Agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on dicamba-tolerant soybean and cotton is provided below. More detailed discussions can be found in the Agency documents titled, *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708)* and *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)*, and its addendums entitled, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean and Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean*. These documents are in the docket. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water

and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would likely persist; however, EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. It may reach surface water via field/site runoff, spray drift during application, and by vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however EPA does not expect DCSA to reach groundwater at levels that would be of concern. The major route of exposure to non-target organisms is likely spray drift and runoff. Also, multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury. The assessments related to these routes of exposure are described in the sections below.

3. Runoff

The Agency has considered the potential effects due to runoff, and has developed proposed mitigation to limit off-site runoff. A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following dicamba applications, likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The Agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). EPA has also determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. Based on the weight of evidence approach, EPA determined that labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (*i.e.* NOAEC for soybean plant height).

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, the Agency had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Though the Agency found the information helpful, the submission did not include enough detail to verify the measurements in the studies. Therefore, in order to be protective of potential effects to non-target plants from volatilization, labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate. Although the Agency is not requiring additional data to be submitted at this time, if EPA receives volatility data under varied conditions of temperature and relative humidity, as these factors play a strong role in volatility under field conditions, it may reconsider whether this mitigation requirement is necessary.

EPA is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being proposed by EPA (400 feet as opposed to 110 to 220 feet). EPA has reviewed the information associated with the larger buffer in Arkansas to assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (*i.e.*, plant height) for the most sensitive plant species tested (*i.e.*, soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the proposed uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are

drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the proposed label. The Arkansas Plant Board felt that a 400 foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic ($RQ = \text{Exposure} / \text{Toxicity}$). RQs are then compared to EPA's levels of concern (LOCs). The LOCs are criteria used by the Agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the Agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including cotton and soybean. The proposed uses on dicamba-tolerant soybeans and cotton would expand the timing of applications from pre-emergence and pre-harvest only for soybeans and pre-emergence and post-harvest only for cotton to allowing post-emergence over-the-top applications. The maximum yearly application rates would remain 2.0 lb a.e./acre for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./acre between pre-emergence and post-emergence applications.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad

default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations.

The results of the screening level risk assessments indicate that the RQs do not exceed the Agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the Agency's LOC. The screening level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both cotton and soybeans, based on the proposed maximum application rates, the screening level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the Agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans. Before considering mitigation measures, EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening level assessment, further refinement, as discussed below, suggest that risks are lower.

1. Risk to Birds

For birds, the screening level assessment indicated that the RQs exceeded the Agency's LOCs on an acute basis for both soybean and cotton. More specifically, the screening level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in dicamba-tolerant soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming soybean forage/hay.

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The Agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs.

Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns, suggesting that dicamba consumed in the diet may possibly be less available than assumed using dose-based exposures. Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger concerns for many food items. In addition, estimates of exposure in screening level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms with territories established at distance from the field. With this last line of evidence in mind, the draft pesticide label requires an in-field 110 to 220-foot buffer to further reduce off-site exposure for birds (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for birds feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

2. Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the Agency's LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening level assessment using the maximum exposure values from empirical datasets for DCSA residues in dicamba-tolerant soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. A screening level assessment using the maximum exposure values from empirical data for DCSA residues in dicamba-tolerant cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the draft pesticide label requires an on-field 110 to 220-foot buffer in all directions to further reduce off-site exposure for mammals (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for mammals feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an Agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the proposed uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift, and for dicots in semi-aquatic areas due to runoff and spray drift. The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that labeling restrictions will help to reduce spray drift off field. The registrant submitted additional studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and the formulation in its application for registration. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1691 herbicide when an adequate buffer is incorporated between the application equipment and the edges of the treated field.

Additionally, to further mitigate against potential risks to plants from spray drift, the product labeling requires the use of 110-220 foot (depending on application rate) buffer between the last treated row and the closest edge of the field to be treated (in all directions). The Agency considered exposure to spray drift to be the principal risk issue associated with the proposed labeled use for all taxa. EPA considered a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting.

4. Synergism

EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. In EPA's risk assessments, the Agency uses GLP guideline studies to determine potential toxicity to plants, involving apical endpoints such as biomass and reproductive health. EPA believes this approach is very reliable for these purposes. However, at this time, the topic of synergy and multiple stressors is an uncertainty in assessing risk to non-target plants including endangered

species. Therefore, EPA is proposing a tank mix prohibition on the M1691 label to address this uncertainty.

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this proposed decision.

In the screening level risk assessment performed for the new application timing of dicamba (DGA) on genetically modified cotton and soybean to be tolerant to dicamba, EPA determined that direct concerns were unlikely (*i.e.* levels of concern were not exceeded) for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <https://www.epa.gov/endangered-species/ecological-risk-assessment-process-under-endangered-species-act>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still

exceeds the Agency's levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species' habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

This registration for dicamba is being proposed for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an assessment of listed species is completed for any such state.

Based on EPA's LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), EPA identified the listed species that are inside the "action area" (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 30 states.

The following criteria were used to assess listed species in the action area:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have "no effect."
- For listed individuals outside the action area, use of a pesticide would be determined to have "no effect."
- Listed individuals inside the action area may either fall into the "no effect" or "may effect" categories depending upon their specific biological needs and circumstances of exposure.

- Those that fall under the “may effect” category are found to be either “likely” or “not likely to be adversely affected.” This determination is made in consultation with the Services
- A “likely” or “not likely to adversely affect” determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift mitigation language including a 360 degree infield buffer (to varying length, depending on application rate) on the label is intended to limit off site transport of dicamba DGA through spray drift, as well as volatilization. Therefore, EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, EPA concluded a no effect determination for all but 24 species originally identified as potentially at-risk (in the screening level assessment) because they are not expected to occur on cotton and soybean fields. The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in EPA’s refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, EPA made a determination that exposure occurring on the field would have “may affects” (either “unlikely to adversely affect” or “likely to adversely affect” on 2 species (the Spring Creek Bladderpod and the Audubon Crested Caracara) in 2 counties (Wilson county, TN and Palm Beach county, FL, respectively) within the States covered by this proposed decision. Furthermore, the Agency has concluded that the 2 species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in both counties, thus mitigating any possible chance of exposure.

Additionally, the Agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, EPA’s analysis supports a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, EPA is proposing to require rainfast mitigation on the label (“Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.”) to protect against the risk of exposure to listed species off the treated field.

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on genetically-modified crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, EPA is proposing, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a

lack of performance can communicate directly with Monsanto by a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the proposed uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label. The registrant must then evaluate the situation to determine if lack of performance is caused by resistance or likely resistance.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy^[i], et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers’ permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15th, 2018, on or before January 15th of each year, Monsanto must submit annual summary reports to EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, county and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The

annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the proposed dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The Agency received 11 comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2010-0496) for the application to register the use of dicamba on genetically-modified soybeans and no comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2012-0841) for the application to register the use of dicamba on genetically-modified cotton. The majority of comments expressed concern (e.g., spray drift and volatilization) and requested that the Agency deny the proposed registration. The EPA welcomes input from the public during the decision process when registering pesticides, and is committed to thoroughly evaluating and mitigating any potential risks from registered pesticides, consistent with applicable statutory standards. EPA considered the public comments received in this regulatory decision.

The commenters focused on spray drift and volatilization concerns affecting non-target plants. The Agency has evaluated the risks regarding the potential drift of pesticides to sensitive crops and other non-target plants that may be adjacent to treatment areas. Specific label directions and restrictions have been proposed to protect from off-target movement of this pesticide product. Specifically, the proposed registration decision requires a 110-220 foot buffer between the treated area and edge of the field in all directions. These buffers are expected to keep spray drift from moving beyond the edge of the crop field to be treated as well as reduce the concern for volatility. In addition, the label will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide to distances within these buffers. The proposed regulatory decision also specifies that this product cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. Label language regarding spray volume, equipment ground speed, and spray boom height is intended to further protect against off-target drift. More details on EPA's and Monsanto's efforts to minimize effects to non-target plant species can be found in Section VIII.B.4 of this document.

Commenters also expressed concerns that weeds resistant to dicamba will become more prevalent as a result of this proposed use. Weed resistance is an increasing problem that has become a significant economic issue to growers. In an effort to address this concern and to prevent new weed resistance from happening, while giving growers another essential tool in their integrated pest management programs, Monsanto must put into place a stewardship program to promote responsible use of the proposed product in order to minimize the potential for increased

levels of weed resistance. This plan is discussed in detail in Section V and Section VIII.B.3 of this document.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Current registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the currently registered use of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba would expand weed management options on genetically-modified cotton and soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season would target new flushes of weeds, thereby reducing populations of these weeds and particularly would help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Proposed Registration Decision

In accordance with FIFRA, EPA only registers a pesticide when it can ensure that it will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, EPA is charged with balancing the uncertainties and risks posed by a pesticide against its benefits. EPA must determine if the benefits in light of its use outweigh the risks in order for the Agency to register a pesticide.

In the case for the proposed use of dicamba on dicamba-tolerant soybeans and cotton, and in consideration of all best available data and assessment methods, EPA believes this proposed decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. The Agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some levels of concern were exceeded for certain birds and mammals that may be in the fields that would be treated. The Agency notes that these are very conservative risk estimates using screening level (worst case) assumptions, and that they most likely do not apply to the majority of the birds and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated

field. Because of these additional restrictions, EPA expects the proposed uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the Agency's levels of concern.

On the benefits side of the analysis, use of dicamba on dicamba-tolerant soybeans and cotton is expected become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of U.S. soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states stretching across the southern half of the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on dicamba-tolerant soybeans and cotton would be beneficial as it provides an effective tool to treat especially noxious weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba could help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to soybean and cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the proposed labeling restrictions will include protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

After weighing all the risks of concern against the benefits of the proposed uses, EPA finds that when the proposed mitigation measures are applied, the risks that may remain are minimal, if they exist at all, while the benefits are potentially great. Therefore, the benefits outweigh the risks and registering these uses will not generally cause unreasonable adverse effects on human health or the environment during the 5-year time limited registration being proposed (a 5-year registration is proposed so that any unexpected weed resistance issues that may result from the proposed uses can be addressed before granting an extension or EPA can allow the registration to terminate if necessary). EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(5) registration finding for the proposed uses.

A. Data Requirements

There are no outstanding data requirements required to support the registration of this action. However, data may be required in connection with registration review activities for dicamba. Those requirements would be generic to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the proposed supplemental labels unless otherwise noted below.

- 1. Worker Protection** *(Although the following Worker Protection labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

- 2. Environmental Hazards** *(Although the following Environmental Hazards labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1691™ for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call XXXXXXXX.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless in conjunction with another mode of action herbicide with overlapping spectrum.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use the Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying M1691 Herbicide. Do not use any other nozzle and pressure combination not specifically allowed by this label.

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and are impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical

air mixing. The inversion will dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

a. Buffer

Maintain a 110-foot buffer (when applying 16 fl oz of this product per acre), or a 220-foot buffer (when applying 32 fl oz of this product per acre) between the treated area and the edge of the field in all directions.

b. Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1691 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1691 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.

- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans.
- The combined total application rate from crop emergence up to 7 days pre-harvest must not exceed 64 fluid ounce (2.0lb a.e dicamba) per acre for cotton.
- All applications for both cotton and soybeans must not exceed 64 fluid ounces (2.0 lb a.e dicamba) per acre.

C. Registration Terms

EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. EPA is basing the proposed registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

Monsanto must have an Herbicide Resistance Management (HRM) Plan for M1691 Herbicide developed and approved by EPA before a final registration can be issued. The HRM Plan must focus on educating growers on the appropriate use of the M1691 Herbicide and the associated dicamba-tolerant seeds. EPA is requiring that the HRM Plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

Monsanto or its representative must investigate reports of lack of herbicide efficacy as reported by users following “scouting.” When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for “likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Additionally, Monsanto must collect material, if possible, for further testing. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if

requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures.

c. Annual Reporting of Herbicide Resistance to EPA

Monsanto must submit annual summary reports to EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, county and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

2. EPA's Continued Control over the Registration

Because the issue of weed resistance is an extremely important issue to keep under control and can be very fast moving, this registration will expire 5 years from the date of the registration issuance, unless this term is removed or modified by EPA. At the end of 5 years, EPA can work to address any unexpected weed resistance issues that may result from the proposed uses before granting an extension or allow the registration to terminate if necessary.

3. Geographic Limitation on Use of Dicamba M1691 Herbicide

EPA is proposing to issue this registration only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62.
<http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

MEMORANDUM

Date: November 7, 2016

Subject: Response to Public Comments Received Regarding the New Use of Dicamba on Dicamba-Tolerant Cotton and Soybeans
Docket ID: EPA-HQ-OPP-2016-0187
Application Date: April 21, 2010 and July 26, 2012

The Agency received 21,710 comments in response to the public participation process (Docket ID: EPA-HQ-OPP-2016-0187) regarding the Environmental Protection Agency's (EPA or the Agency) proposed decision for the application to register the use of dicamba on genetically-engineered (GE) cotton and GE soybean that have been engineered to be resistant to dicamba.¹ Comments received were both in favor of and opposed to the decision to register the new uses which will provide growers with additional tools to control broadleaf weeds. The EPA welcomes input from the public during the decision process when registering significant new uses for registered pesticides and is committed to thoroughly evaluating these comments and determining whether mitigation measures are necessary to meet the applicable statutory standards. Also, EPA strives to document and explain the basis of its regulatory decisions through these and other public documents. Due to the large volume and similar themes of many of the submitted public comments, the EPA is responding to these comments by grouping them together by subject matter.

These new dicamba uses were originally proposed by the Monsanto Company to be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582). This is the specific formulation that was listed in the Agency's Proposed Decision released for public comment earlier this year. Since the proposed decision was published, the Agency assessed a lower volatility dicamba formulation (M1768, with the brand name Xtendimax™ with VaporGrip™ Technology, EPA Registration Number 524-617). This lower volatility formulation is expected to further reduce the potential off site movement of generic dicamba formulations. The M1768 product contains the same active ingredient as M1691, diglycolamine (DGA) salt of dicamba, and is to be used with equivalent application rates and the same application techniques. Because the two products contain the same active ingredient used at the same rates with the same methods, all of the environmental and human health assessments completed and made public in connection with the proposed registration decision for the M1691 apply to M1768. After assessing volatility studies conducted on the M1768 formulation (discussed in the document, "Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean," available in this docket), EPA has determined that the new lower volatility formulation of M1768 offers the user a product with less potential to volatilize off-

¹ The terms "genetically-engineered to be resistant to dicamba" and "dicamba-tolerant" are considered to have the same meaning in this document.

site. The volatility analysis is included in the docket for this final decision.

I. Human Health

A common concern expressed in the submitted comments regarded the human health effects of the potential increased use, and therefore exposure, of dicamba.

A. Overarching Concerns:

Comments were received concerning whether vulnerable populations and effects on the immune system and neurological function were included in the assessments. Concerns about potential contaminants in dioxin formulations were also expressed.

Response: EPA has carefully assessed the potential risk concerns to all populations, including infants, children, and pregnant women in its human health risk assessment. The toxicity and exposure databases for dicamba are complete and robust, including a comprehensive database of studies conducted under Good Laboratory Practices (GLP) related to risks to infants, children, and developing fetuses. These toxicity studies examine developmental and reproductive toxicity, the potential for chronic, cancer, and mutagenic effects, neurological and immunotoxicity, and consider multiple forms of dicamba as well as effects from various potential routes of exposure to the chemical. EPA also examined potential risk concerns for contaminants which might be present in dicamba formulations, as is done in all pesticide risk assessments. EPA carefully considered all of these data and completed its assessments using scientifically sound and protective assumptions and approaches, consistent with approaches used and recognized internationally. Using these protective assumptions, no risks of concern were identified from any dicamba exposure, including dietary, residential, or occupational exposures.

B. Cancer:

Commenters expressed concern that EPA is only approving new combinations of toxic chemicals that have carcinogenic potential. There was particular concern that dicamba is an older chemical, and may have cancer and neurological concerns. Some commenters urged the Agency to focus on getting rid of chemicals that pose cancer risk.

Response: The Agency carefully examined both the laboratory animal and epidemiological data for dicamba and determined that dicamba is not likely to be carcinogenic to humans. In accordance with the EPA Final Guidelines for Carcinogen Risk Assessment (March 29, 2005), dicamba is classified as “not likely to be carcinogenic to humans” (*“RfD/Peer Review Report of DICAMBA: 2-Methoxy-3,6-dichlorobenzoic acid, or 3,6-dichloro-o-anisic acid”*, Henry W. Spencer, Ph.D., 7/29/96). This decision was based on the lack of findings in the cancer studies in rats and mice which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba, although some positive results were reported *in vitro*. Dicamba acid and the dicamba BAPMA salt both induced chromosomal aberrations in human

lymphocytes *in vitro*; however, genotoxicity was negative *in vivo* in the mouse micronucleus assay, thus the concern for genotoxicity for dicamba or its salts is low. The BAPMA base was negative for genotoxicity in bacteria, but positive for genotoxicity based on *in vitro* mammalian cell culture. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

With regard to epidemiological data, in an Agricultural Health Study (AHS) paper entitled “Cancer Incidence among Pesticide Applicators Exposed to Dicamba in the Agricultural Health Study,” authors found no “strong associations” between dicamba exposure and either overall or site-specific cancer risk. (Samanic, et al. 2006). In this study, Samanic et al. incorporated incident cancers diagnosed between enrollment (generally between 1993 and 1997) and December 31, 2002 by linkage to state cancer registries. Poisson regression was used to estimate rate ratios and associated confidence intervals by tertiles of dicamba exposure. The authors concluded that “Exposure was not associated with overall cancer incidence nor were there strong associations with any specific type of cancer.” More specifically, no statistically significant associations were seen using intensity-weighted lifetime exposure days and the “No exposure” group as a referent category for either “any cancer (overall)” and for site-specific cancers. While a trend was apparent for lung cancer when the low exposed group was the referent ($p = 0.02$) for lifetime exposure days, no evidence for trend was reported when the unexposed group was the referent for lifetime exposure days. Additionally, no trend was reported for any lung analyses considering intensity-weighted lifetime exposure days (IWLD). For colon cancer, a trend was apparent for both lifetime exposure days and IWLD when the low exposed group was the referent, and also for IWLD when the no exposure group was the referent (*ranging from p -for-trend = 0.002 to 0.02*). However, these trends appeared to be due largely to the elevated risk at the highest exposure level and point estimates generally had wide confidence intervals with relatively small number of cases ($n \leq 20$ in the low exposure group referent and $n \leq 76$ in the no exposure group referent analyses). The authors concluded that they found little evidence for an association between dicamba exposure and any of the cancer sites investigated, but the patterns of associations observed for lung and colon cancers warrant further attention.

Based on the weight of evidence of these findings, HED believes there is sufficient evidence to conclude that dicamba is not likely to be carcinogenic to humans.

While neurotoxicity and possibly developmental toxicity were observed in animal studies, dose levels chosen to quantify risks (called “Points of Departure,” or PODs) were lower than the dosing levels used in these studies at which no adverse toxic effects were observed; therefore, quantifying risks using these PODs is protective for these effects. Furthermore, appropriate safety factors were applied to account for inter-species extrapolation and intra-species variability to assure that potential risks would not be underestimated.

Highly protective ground and surface water modeling was completed to estimate potential exposures through drinking water; these models will not underestimate exposure. EPA’s Office of Pesticide Programs (OPP) uses a tiered approach to estimate pesticide concentrations in drinking water sources. Estimated Drinking Water Concentrations (EDWCs) resulting from Tier 1 or 2 assessments represent pesticide use on sites that are highly vulnerable to leaching or runoff. This initial tier (Tier I) of the drinking water assessment process is designed to screen out chemicals with low potential risk for posing a drinking water concern. Risks associated

with these exposures were not of concern, even when aggregated with risks from food and residential exposures.

HED also completed an assessment of high-end exposures which might potentially occur as a result of spray drift. Risks associated with these exposures were not of concern, even at the edge of a treated field.

C. Specific Concerns Regarding Individual Studies and Assessment Methodologies (Center for Food Safety Comments):

1. *“Both studies revealed statistically significant evidence of carcinogenicity. EPA dismissed the significant dose-response trend of increasing tumors with increasing dicamba dose in male rats because pairwise comparisons were not significant. A significant pairwise comparison result in the mouse study was dismissed because dose-response was not significant. Neither study incorporated a maximum tolerated dose, which is critical for legitimate application of the pairwise comparison test. Unless other studies that incorporate maximum tolerated doses are conducted and their results definitively refute the present findings, based on existing evidence EPA should properly find that dicamba is carcinogenic.”*

Response: In 1995, the RfD Peer Review Committee determined that the doses tested in the rat and mouse carcinogenicity studies were inadequate for evaluating the carcinogenic potential of dicamba based on the lack of toxicity observed in those studies (HED Doc 012037, 7/29/96). Subsequent to this evaluation, the registrant conducted saturation kinetics studies to better understand the pharmacokinetics of dicamba in rodents. The pharmacokinetic data were reviewed by the HED Dose Adequacy Review Team (DART) and determined that the doses tested in the rat and mouse carcinogenicity studies were adequate to assess carcinogenicity (TXR 0053647, 8/16/05). This decision was based on the following lines of evidence:

- The 90-Day plasma pharmacokinetic (PK) study (MRID 46022302) (dose levels: 50, 100, 200, 400, or 800 mg/kg dicamba/day) showed evidence of saturation of excretion at doses >200 mg/kg/day. When saturation of excretion is reached the concentration of dicamba excreted from the kidney has plateaued. Therefore, the uptake and excretion of dicamba is no longer occurring in a linear fashion. In the 90-day plasma PK study, plasma AUC increased with dose, but the increases were non-linear and disproportionate at doses >200 mg/kg/day. This result is consistent with saturation of excretion. The results showed that the saturation point, the point where the excretion of dicamba from the kidney has plateaued, occurred somewhere between >200-400 mg/kg/day, with saturation not being reached at 200 mg/kg/day, but definitely reached at 400 mg/kg/day. The PK study with probenecid (MRID 46022301) provided support that the nonlinearity of blood levels was due to a saturation of the active transport pathway in the kidney. The PK data support that the doses used in the mouse and rat carcinogenicity studies are adequate for determining the carcinogenic potential of dicamba. Conducting additional cancer studies at higher doses where non-linear kinetics is occurring is not appropriate for risk assessment purposes.

- The high doses in the carcinogenicity study (107/127 mg/kg/day, in males/females, respectively) were within a factor of around two-fold of the saturation point (>200-400 mg/kg/day) and retesting at higher doses (e.g., >300 mg/kg/day) may lead to potential problems with saturation as determined by the pharmacokinetics study (i.e., definite saturation at 400 mg/kg/day).
- Supporting data from the subchronic toxicity studies showed that no effects are expected to occur at or below the saturation point. The dietary subchronic toxicity and subchronic neurotoxicity studies in rats had NOAELs ranging from 400-500 mg/kg/day with LOAELs ranging from 700-1000 mg/kg/day, based on liver pathology (subchronic toxicity study [MRID 44623101]) and rigid body tone, slightly impaired righting reflex and gait (subchronic neurotoxicity study [MRID 43245210]).
- The Structure Activity Relationship (SAR) showed that the concern level for carcinogenic potential is low. According to the OncoLogic Cancer Expert System, there is a Low-Moderate concern for para-dichlorobenzene but the substituents of dicamba lower the concern to Low. A structurally similar chemical, 2,4-D, is negative for carcinogenicity with a negative Ames test but positive chromosomal aberration and CHO tests. Other structurally similar chemicals, 5-chlorosalicylic acid, dichlorobenzoic acid, and chlorobenzoic acid have negative Ames tests, but no carcinogenicity data are available.

Although no evidence of systemic toxicity was observed in either carcinogenicity study with dicamba, the adequacy of the doses tested in the studies is supported by the pharmacokinetic/toxicokinetic data and testing at higher concentrations would likely result in non-linear kinetics. This decision is consistent with the Agency's Guidelines for Carcinogenic Risk Assessment (EPA, March 2005), which states that "The high dose in long-term studies is generally selected to provide the maximum ability to detect treatment-related carcinogenic effects while not compromising the outcome of the study through excessive toxicity or inducing inappropriate toxicokinetics (e.g., overwhelming absorption or detoxification mechanisms)."

The Agency determined that there were no treatment-related tumors in the rat or mouse carcinogenicity studies following treatment with dicamba. Although there was a statistically significant trend ($p < 0.05$) for both malignant lymphoma and thyroid parafollicular cell (C-cell) carcinoma in the male rats (MRID 00146150), pairwise comparisons showed no statistical significance at any dose for either tumor type. There were no preneoplastic or supporting non-neoplastic lesions to indicate that these increases are treatment related. Additionally, these tumor types are not uncommon and can occur spontaneously in aged CD-1 rats. In the mouse study (MRID 40872401), there was a statistically significant ($p < 0.05$) increase in the incidence of lymphosarcomas in female mice at 150 ppm; however, no statistically significant increases were seen at higher doses (1000 or 3000 ppm) and there was no clear monotonic dose response for this tumor finding (2/52, 4/51, 8/52, 7/52 and 5/52 for doses of 0, 50, 150, 100 and 3000 ppm, respectively). Furthermore, the incidence for spontaneous lymphosarcomas in the testing laboratory for this strain of mice in the testing laboratory that conducted this study is 6-

33%. The incidence of lymphosarcomas in the concurrent controls was 3.8% (2/52). The historical control data provided additional evidence to support that the statistically significant pairwise increase seen only at 150 ppm was likely due to the lower than expected spontaneous incidence of this tumor type in the concurrent controls.

2. *“Even though rat pups were 10-fold more sensitive to DCSA than adults, EPA did not apply the additional 10X safety factor demanded by the Food Quality Protection Act (FQPA) when toxicology tests demonstrate that the young are more susceptible than adults.”*

Response: Although quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, the degree of concern for the susceptibility is low because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are based on the no-observed-adverse-effect level for the most susceptible population identified, are health protective, and therefore address the concern for offspring toxicity observed in this reproduction study.

3. *“Point of Departure based on beagle study not considered by EPA.”*

Response: The Center for Food Safety states that the Agency has “failed to consider” a 2-year dog study previously used by the Agency as a basis for the chronic reference dose (cRfD); this is incorrect. HED has reexamined the cRfD (and the chronic population adjusted dose, cPAD) for dicamba as new toxicity data have become available; the available dog toxicity studies were included as part of these reviews. The referenced 2-year dog toxicity study was determined to be unacceptable with too few animals available for examination and was superseded by a one-year study in which no toxic effects were observed at dose levels up to approximately 52 mg/kg/day. When considering the weight of evidence of all available toxicity data, the NOAEL of 4 mg/kg/day based on decreased pup weights in the DCSA metabolite reproductive toxicity study in rats provided the most robust point of departure and endpoint for risk assessment, and was considered protective for toxic effects observed in all other reliable toxicity studies.

4. *“EPA should consider potential human health impacts from exposure to formaldehyde in food or feed derived dicamba-resistant soybeans and cotton that has been treated with dicamba.”*

Response: If formaldehyde were to be formed as a degradate of dicamba, the Agency believes that any dietary exposures to the compound will not result in risks of concern – protecting for

residues of the parent compound and its other metabolites in the diet using the most sensitive toxicological endpoints and exaggerated estimates of exposure for these chemicals will also be protective for any minimal formaldehyde exposure potential. We also note that formaldehyde is naturally present in numerous foods and in the human body; any traces of formaldehyde resulting from dicamba use will not be of dietary risk concern. Similarly, any trace amounts of formaldehyde formed as a result of dicamba use will be insufficient to result in dermal or inhalation risk concerns.

5. “EPA’s Current Assessment Entirely Fails to Consider Toxicity of Conjugated Metabolites of Dicamba.”

Response: The toxicity and exposure databases for dicamba are complete and robust. Analytical methods for data collection and tolerance enforcement use acid hydrolysis extraction procedures in order to account for all the residues of dicamba including its conjugated metabolites. These methods convert the residues of dicamba including its conjugated metabolites to the stoichiometric equivalent of the parent and combined with the level of parent residues for determination. HED has therefore carefully considered all of these data in completing its assessments to assure that potential risks would not be underestimated. Additionally, The Center for Food Safety (CFS) document referenced 8 studies of epidemiological data investigating health effects associated with dicamba (CFS document pages 31 - 32). Below is a list of these articles and a brief overall statement. For additional details including quantitative information and direct quotes from the articles as well as our responses as appropriate, See Appendix I, which excerpts the epidemiology paragraphs in the CFS document and responds via comment by sentence.

Based on a screen of the referenced articles from the CFS document (listed below), we found insufficient evidence of a clear or causal association between dicamba and cancer.

1. Samanic et al. 2010: Overall, we feel that only one comment by CFS – that EPA failed to identify the cancer site for the reported p-trend we reported – is valid. Furthermore, we feel that EPA should have reported additional significant findings from the Samanic et al. paper in its previous document. In the attachment to this memo, we elaborate on the findings of this study and address points raised by CFS by sentence. However, we feel that the overall conclusion of EPA in its previous document properly acknowledged the study conclusion that “Although associations between exposure and lung and colon cancer were observed, we did not find clear evidence for an association between dicamba exposure and cancer risk.” (Quote from Samanic et al.)
2. Alvanaja et al. 2004: The inconsistency in the study results makes drawing a conclusion about associations difficult. A statistically significant positive trend for lung cancer

association with dicamba was seen in analyses that used low exposure as a referent category ($p = 0.04$) but not in analyses that considered no exposure as the referent. (p trend = 0.15). Significant positive associations between dicamba is seen in only one analysis: the highest exposure group ($n = 8$ exposed cases) when the low exposure group is the referent (21 exposed cases). This is not seen in other point estimates of the odds ratio, nor in the odds ratio for the highest exposure group when the no exposure group is the referent (95 exposed cases). Further information is included in the attachment to this memo.

3. McDuffie et al. 2001 (NHL): Investigators identified evidence of a positive association between dicamba and NHL (see attachment to memo for quantitative details). Additional studies, preferably in different populations by different researchers, investigating associations between dicamba and NHL are necessary to provide sound evidence. We considered the 7 other studies referenced by CFS and found only one (Cantor et al. 1992) that contained original data and supported evidence of a positive association, but -- as noted below -- the odd ratios reported in Cantor et al. are not statistically significant and the case and control numbers are quite small. In contrast, Samanic et al. 2010 found no evidence of an association between dicamba and NHL. In the absence of additional studies corroborating the findings of McDuffie et al. (2001), we consider McDuffie's results as insufficient evidence of an association between dicamba and NHL.
4. Cantor et al. 1992 (non-Hodgkin's lymphoma (NHL)): While elevated, the odds ratios are not statistically significant (encompass the null value of 1.00). Furthermore, the case and control numbers are quite small.
5. Schinasi and Leon 2014: The meta-analysis was run on just two studies considering the association between dicamba and NHL (McDuffie et al. 2001 and DeRoos et al. 2003). While the authors reported meta-analytic summary RR elevated, we have considered 1.00 as the null value in previous reports and consider this singular result not statistically significant.
6. Weichenthal et al. 2010: In this review article, Weichenthal does not contribute additional analyses beyond reporting the findings of Samanic et al. 2010 and Alavanja et al. 2004; therefore, we did not respond to Weichenthal directly.
7. Burmeister 1990: There was no specific mention of dicamba exposure.
8. Blair and Zahm 1995: There was no specific mention of dicamba exposure.

D. Worker Exposure

Comments were received which expressed concern about the health and safety of farm workers and rural communities, particularly regarding cancer risks, birth defects, and developmental toxicity.

Response: EPA has assessed potential risks from exposures to pesticide applicators, farmers and rural communities, as well as to other potentially exposed individuals. This assessment included consideration of both guideline toxicity studies and epidemiological data for cancer

and developmental toxicity, as well as a wide range of other toxic effects. Exposure assumptions and safety factors were chosen to assure protection of public health. Please see responses to related comments, above, for more detailed information.

II. Environment

A large volume of the submitted public comments related to the environmental risk assessments. Comments with common themes have been grouped together by subject matter and are addressed below. EPA appreciates all comments received and thanks these commenters for participating in the public process for this dicamba action. Although many commenters suggested that we consider additional data for the risk assessment, ultimately, none of the submitted comments contain quantitative information that can be used to modify the environmental risk assessment.

A. Spray Drift and Volatility

Comment: Increasing the annual usage of dicamba when meteorological conditions increase the likelihood of drift and when adjacent plants are most susceptible will dramatically increase injury to adjacent crops and field-edge plants. The use of the new dicamba formulations will dramatically decrease plant biodiversity and the provisioning of natural enemies and pollinators.

Response: Based on the available data, the in-field buffer on the labeling is expected to reduce any potential effects from dicamba drift to off-field plants to below levels of concern as established by EFED's assessments.

Comment: Simulated dicamba drift to tomato crops in one study conducted by Ohio State University researchers shows that applications of dicamba at levels as low as 1/300th of the soybean field rate caused statistically significant losses of tomato crops.

Response: The No Observed Adverse Effect Concentration used in EFED's dicamba risk assessment is 0.000261 lb/acre, which is approximately 1/900th the field application rate (assuming a 0.5 lb/acre dicamba application rate) and therefore protective of the crop sensitivity cited.

Comment: Research by Behrens and Lueschen (1979) suggests that for the dimethylamine salt of dicamba, laboratory volatility data are not predictive of volatility in the field.

Response: EPA disagrees with this comment for the following reasons. First, the field volatility study citation submitted by the Center for Food Safety does not provide data on the DGA (diglycolamine) salt of dicamba, but rather the more-volatile DMA (dimethylamine) salt. Second, EFED reviewed four new field volatility studies (MRIDs 49888401, 49888403, 49888501, and 49888503) related to the M1691 and M1768 products under consideration and conducted according to OCSPP guideline 835.8100 as referenced in the Monsanto comment (EPA-HQ-OPP-2016-0127-0016) and also evaluated Monsanto's submitted laboratory

volatility data (MRIDs 49770303, 49888605, and 49925703) and found that the M1691 (dicamba DGA) and M1768 (dicamba DGA plus VaporGrip™) products are less volatile than dicamba acid and dicamba DMA. Third, EFED employed a weight of evidence approach considering all data, from both the laboratory and the field, relative to the M1691 dicamba DGA salt. Based on its review of the submitted studies and modeling exercises, EFED finds that the 110 to 220-foot (for 0.5 and 1.0 lb ae/A application rates, respectively) omnidirectional buffer for volatilization is no longer necessary; however, the in-field spray drift buffer of 110 to 220 feet downwind at the time of application must be maintained because spray drift remained the primary concern for off-site exposure (USEPA, 2016b).

B. Buffer

Comment: Many comments opposing the proposed omni-directional 110 foot in-field buffer (for the 0.5 lb ae/A application rate) were received. These commenters cited the low volatility of the proposed formulation among other reasons why the buffer should instead be a one sided wind-directional buffer of the same or lesser distance.

Response: After review of new data on volatility, EPA agrees that an omni-directional buffer is no longer needed to address volatility concerns. EFED's second amendment to the environmental fate and ecological risk assessment for dicamba DGA salt (USEPA 2016, D426789) used a weight of evidence approach to establish the wind-directional 110 foot in-field buffer (for the 0.5 lb ae/A application rate). Further discussion in the vapor analysis section of the dicamba M1691 proposed new use on dicamba-tolerant cotton (USEPA, 2016a) suggested that an omnidirectional in-field buffer of the same distance should be considered to mitigate vapor drift based on the results of one open literature study (Egan and Mortensen, 2012). Monsanto Company submitted additional data outside of the public comments, and EFED reviewed four recently submitted field volatility studies (MRIDs 49888401, 49888403, 49888501, and 49888503) related to M1691 and M1768. These studies were conducted according to OCSPP guideline 835.8100 as referenced in the Monsanto comment (EPA-HQ-OPP-2016-0127-0016). Based on review of the submitted studies and modeling exercises, EFED finds the 110 to 220-foot omnidirectional buffer for volatilization is no longer necessary; however, the in-field spray drift buffer of 110 to 220 feet downwind at the time of application (for 0.5 and 1.0 lb ae/A application rates, respectively) must be maintained because spray drift remains the primary concern for off-site exposure (USEPA, 2016b).

Comment: Requiring a 110 ft buffer is not justified by research conducted in Georgia. There are other methods of reducing the exposure of nontolerant plants that are more effective and have proven less damaging to a field's overall productivity.

Response: The Georgia Department of Agriculture would need to submit research reports in order for EFED to evaluate this claim that the 110 foot buffer is not justified. EFED has determined through a weight of evidence approach that a 110 foot downwind spray drift buffer will be protective of the apical endpoints of EFED's ecological risk assessment (USEPA, 2016b).

Comment: Volatility buffers should be developed using field research data based on soil temperature and land terrain.

Response: EFED is aware that soil temperature and land terrain may affect volatility; however, it is impractical to account for local terrain in a multi-state assessment. The volatilization modeling that was conducted accounts for temperature effects. Based on field studies submitted by the registrant and volatilization modeling, the 110 to 220-foot omnidirectional buffer for volatilization is no longer warranted for the M-1768 formulation because the expected exposure at field's edge is less than the NOAEC. A volatility buffer for the M-1691 formulation is also not warranted because EPA determined that the exposure is ten-fold less than the lowest effect level (LOAEC) at the edge of the field (USEPA 2016b). However, EFED finds that the in-field spray drift buffer of 110 or 220 feet (for the 0.5 and 1.0 lb ae/acre application rates, respectively) downwind at the time of application must be maintained, because spray drift remains the main concern for off-site exposure (USEPA 2016b).

Comment: Data show that the product will move more than 400 feet at wind speeds allowed under the proposed label... There is another formulation of dicamba that has less risk, and we are hopeful that formulation improvements will result in a safer, more flexible product that is eventually commercialized.

Response: EFED is aware that wind speed is a determining factor behind the extent of spray drift; however, EFED finds that, based on the weight of evidence, the in-field spray drift buffer of 110 feet downwind at the time of application is sufficient to mitigate off-site spray drift exposure concern (USEPA 2016b). EFED considers the maximum application wind speed restriction (15 mph) in conjunction with the in-field buffer specified on the approved labeling sufficient to reduce any potential effects from dicamba drift to off-field plants to below levels of concern as established by EFED's assessments.

Comment: The Arkansas restrictions on buffer zones of 400' seems like a reasonable safeguard against volatility for the "safer" formulations, Engenia and M1691. The Arkansas restriction on a one-mile buffer zone for the older generic formulations should be utilized.

Response: The Agency is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being set by EPA (400 feet as opposed to 110 to 220 feet) and that the Arkansas Plant Board is currently considering whether these buffers should be increased. EPA has reviewed the information associated with the larger buffer in Arkansas to

assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (i.e., plant height) for the most sensitive plant species tested (i.e., soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the new uses specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the new label. The Arkansas Plant Board felt that a 400-foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made. The data and conservative modeling utilized by the Agency indicate that a 110 to 220-foot wind-directional buffer (for 0.5 and 1.0 lb ae/A application rates, respectively) will be protective of off-field effects.

C: Sensitive Crops/Areas:

Comment: The proposed label has language requiring that wind be blowing away from sensitive crops, but it appears that little education on such an important issue appears is being done. Additional education for applicators needs to be required in order to help prevent expensive crop damage.

Response: The Agency believes that the label includes clear, directive language to instruct applicators on how to avoid spray drift when applying the product. EPA also agrees that careful application involving best drift management practices should always be employed, and that educating applicators about these practices is good stewardship on the part of the registrant. The terms of registration require that Monsanto develop an education program that will provide growers with the best available information on herbicide resistance management. The Agency is aware that Monsanto has developed an in-depth training program for growers to ensure that the label mitigation is understood and followed. Monsanto's training and education program will emphasize the requirements designed to prevent adverse effects from spray drift, as well as those designed to promote weed resistance management.

Comment: The wind speed restrictions are confusing, and could be more clearly communicated, particularly with regard for winds in the >10 – 15 mph range.

Response: In the Spray Drift Management section, the label states:

“Drift potential is lowest between wind speeds of 3 -10 mph. Do not apply when wind speed is greater than 15 mph.

Wind speed Application conditions and restrictions:

<3 mph Do not apply *Xtendimax™ with VaporGrip™ Technology*

3-10 mph Optimum *Xtendimax™ with VaporGrip™ Technology* application conditions provided all other application requirements in this label are met.

>10 – 15 mph Do not apply product when wind is blowing toward sensitive areas

> 15 mph Do not apply *Xtendimax™ with VaporGrip™ Technology* ”

While the “>10 – 15 mph” category may seem a bit awkward, it is necessary to state it in this manner. Winds of 10 mph are still in the “optimum” range, but winds greater than 10 mph are in the next category.

The label also requires a 110-foot buffer (200 feet for applications of 44 fl oz/A) in the direction the wind is blowing between the site of application and any sensitive area. The buffer requirement is regardless of wind speed. The wind speed conditions and restrictions in the Spray Drift Management section of the label are intended to provide additional protection when winds are in the less optimal 10-15 mph range by prohibiting spraying if these winds are blowing toward a sensitive area.

Comment: Concern that by highlighting certain sensitive crops on the label, other sensitive crops might be ignored by the applicator.

Response: Dicamba is a broadleaf herbicide, and therefore any broadleaf plant is susceptible to damage from dicamba. The language is intended to increase the applicators’ awareness of circumstances where neighboring crops may be vulnerable to damage. The label restrictions, such as the wind-directional buffer, are intended to prevent off-site exposure to such areas.

D. Spray Nozzle

Comment: Concern that there is not enough focus on droplet size in the spray drift considerations/mitigation.

Response: The evaluation of spray drift, resulting in the need for a specific make and model of nozzle, was based on numerous studies, conducted in wind tunnels and in the field. Droplet size is one component of these studies, and is an inherent part of the analysis of a nozzle’s suitability. Additional nozzles could be approved for use once data has been developed which demonstrates that the nozzle and pressure generate a droplet spectra that falls within that evaluated in our current assessment. The label will provide a website where users may find a list of approved nozzle and pressure combinations.

Comment: Many commenters were surprised that the draft label stipulates a specific make and

model of spray nozzle rather than a performance standard for suitable nozzles.

Response: EFED is working with stakeholders to expand the number of suitable nozzles available and the range of conditions under which the new dicamba products can be applied. Concurrently, EPA is participating in ongoing efforts to implement drift reduction technologies (DRT) to reduce off site movement. EPA will work to expand the range of conditions for this and other products where those conditions have been quantitatively demonstrated to be sufficiently protective of the apical endpoints used in EFED ecological risk assessments. Until that effort is complete, requiring this specific nozzle is protective.

E. Tank Mixes/Synergy

Numerous comments were received regarding tank mixtures and the need for farmers to be able to tank mix multiple herbicides to provide effective control of multiple weed species in one pass. There was also concern that restricting tank mixing prevents a multiple-mode-of-action approach for weed resistance management.

Response: EPA has considered these comments and agrees that the benefits of tank mixing, in general, are compelling and meaningful, however whether to include tank mixing restrictions is made on a case-by-case basis. A further issue for assessing the need for tank mixing restriction is whether the U.S. Patent and Trademark Office has granted a patent for that specific combination, or EPA has information that shows true synergism (*i.e.* greater than additive toxicity between different active ingredients) with tank mixing. EPA believes synergism to be a rare event, and intends to follow the National Research Council's recommendation for government agencies to proceed with estimating effects of pesticide mixtures with the assumption that the components have additive effects in the absence of any data to support the hypotheses of a synergistic interaction between pesticide active ingredients. However, EPA also acknowledges that at least some data appear to exist in connection with patent claims filed with the U.S. Patent and Trademark Office of synergism for specific combinations of dicamba with other herbicides. Those data have not yet been reviewed by EPA and will be further evaluated. Accordingly, the Agency is continuing its work with that information in order to better understand the scope of these uncertainties for these specific combinations and to develop an approach that best manages the potential risks while still maintaining the important benefits derived from tank mixing. While evaluation of these data are still in progress, we are requiring a restriction on the end-use product labels that prohibits tank mixing. If the Agency determines that sufficient data do not exist to support true synergistic effects with a particular active ingredient, then that active ingredient may be added to the list of acceptable tank mix combinations.

Comment: Concern about compatibility and potentially increased drift/volatility when tank mixing the diglycolamine salt of dicamba with another pesticide.

Response: EFED's ecological risk assessments considered the M1691 and M1768 diglycolamine salt of dicamba formulations, and the fact that tank mixtures weren't allowed according to the labeling. The scenario described in this comment illustrates the conceptual intent behind the tank mix prohibition on the approved labels, *i.e.*, chemistry changes in the applicator's tank may alter the risk associated with pesticide application.

Comment: A greenhouse study recently conducted in the Southeast does not support the premise that dicamba tank-mixed with various active ingredients (e.g., glyphosate, S-metolachlor, acetochlor) causes more injury to soybean than dicamba applied alone. The study tested tank mixtures at simulated drift rates from 1/15X to 1/1600X and found that only the 1/15X rate resulted in significantly reduced plant height and biomass compared to dicamba alone. Since drift rates are far less than the 1/15X rate, there are no data to support the premise that mixtures are synergistic at true drift rates.

Response: The referenced study quantitatively documents effects relative to the apical endpoints in a way that could be translated to EFED's ecological risk assessment for the chemical combinations tested. However, EFED is aware of patent claims for synergism of dicamba and glyphosate filed with the U.S. Patent and Trademark Office. Thus, while the referenced study may not demonstrate an enhanced effect of mixtures relative to dicamba alone at realistic field drift levels, these patent claims are still being evaluated.

Comment: Adjuvants that pass the compatibility mixture test should be approved by EPA and made publicly accessible before the planting season begins.

Response: A list of EPA approved adjuvants will be publicly accessible via a URL to be included on the final label.

F. Plant Toxicity

Comment: Greenhouse studies do not represent the field and significantly over-estimate damage that is noted in field studies receiving the same treatment.

Response: Although terrestrial plant ecotoxicity endpoints were determined from greenhouse studies, additional higher tier field-level data, provided by registrants and/or found in the open literature, were considered in EFED's risk assessments for dicamba use on dicamba-tolerant soybean and cotton.

G. Insect Pollinators

Comment: Post emergence application of dicamba to dicamba-tolerant cotton and soybean crops may result in direct or indirect effects to insect pollinators such as honey bees and butterflies.

Response: EPA recognizes the importance of insect pollinators and that honey bee and butterfly population declines are a complex phenomenon to which pesticide exposure may contribute. The EPA strives to incorporate the most up-to-date pollinator data and risk assessment practices into its analyses. In the 2016 new use risk assessment for dicamba on dicamba-tolerant cotton (USEPA, 2016a), EFED used multiple lines of evidence [e.g., low acute toxicity to adult honey bees, low acute and chronic toxicity to similar taxa (i.e., aquatic invertebrates)] to conclude that chronic toxicity to adult and larval honey bees is also likely to be low. Additionally, dicamba is currently being reassessed in Registration Review. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

H. Bacterial Resistance

Comment: The US EPA should formally consider the sub-lethal effects of herbicide exposures on bacteria in both the human health and environmental risk assessments. The assessment should be based on the relevant commercial formulations to take into account all ingredients – active and inert – that might induce a change in bacteria responses to antibiotics.

Response: At this time, EFED does not consider the effects of pesticide active ingredients or end-use products on microbial communities. If data are available to demonstrate how impacts to microbial communities relate to the apical endpoints of EFED's assessment method they will be considered; however, at this time EFED is unaware of any such studies.

I. Regulatory and Statutory Issues

Comment: Dicamba is currently undergoing Registration Review. EPA should delay its decision until the comprehensive Registration Review risk assessment, including endangered species, has been completed for this chemical.

Response: EPA began the Dicamba Registration Review (under FIFRA section 3(g)) process in 2016. Given that Registration Review is a lengthy process, the EPA believes it is reasonable to continue to make registration determinations for new actions during this process. New registrations are held to the most current data requirements and up-to-date risk assessment practices and must meet the FIFRA no unreasonable adverse effects standard in order to be registered. As stated in the November 2014 *Interim Report to Congress on Endangered Species*

Act Implementation in Pesticide Evaluation Programs (submitted by EPA, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the U.S. Department of Agriculture), “EPA intends to complete Overview Document-compliant endangered species assessments for new herbicide tolerant crop uses.” See <https://www.epa.gov/sites/production/files/2015-07/documents/esareporttocongress.pdf> at page 22. Consistent with this Report, EPA conducted a species-specific endangered species assessment for the use of dicamba on the GE soybean and GE cotton crops. (USEPA 2016c, USEPA 2016d, USEPA 2016e). These new uses will be reassessed along with all the other registered uses for the active ingredient dicamba during the Registration Review process.

Comment: Effects to migratory birds were not assessed, as required, under the Migratory Bird Treaty Act.

Response: Migratory birds are assessed as part of EFED’s standard screening-level risk assessment process. Migratory birds are included in the risk conclusions for non-listed birds (for those species that have not been designated as threatened or endangered under the Endangered Species Act), and listed birds (for those species that are threatened or endangered). Acute exposure risk concerns were identified for both listed and non-listed birds in the screening level assessment. The refined endangered species spray drift risk assessment addendums (USEPA 2016c, 2016d, 2016e) for the 34 states made a “no effect” determination for threatened and endangered birds with the exception of the Eskimo curlew (where the determination was “may affect, not likely to adversely affect” based on informal consultation with the USFWS) and the Audubon’s crested caracara (where a “no effect” determination was made for soybean; a “no effect” determination was made for cotton in all counties except Palm Beach County, FL where a “may effect, not likely to adversely affect” is the conclusion). The Agency has concluded that the two species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in Palm Beach County, FL, thus mitigating any possible chance of exposure. A memorandum of understanding (MOU) on the Migratory Bird Treaty Act between EPA and the Department of Interior’s Fish and Wildlife Service is in development; the public comment period ended March 7, 2014 ([EPA-HQ-OPP-2013-0744 at www.regulations.gov](http://www.regulations.gov)). The dicamba risk assessment is in accord with the process outlined in the MOU.

Comment: Direct and indirect effect determinations were not made for all species.

Response: EPA’s ecological risk assessment considered both direct and indirect effects to non-target organisms, including listed species. Indirect effects occur when a species that is not directly affected by the pesticide use rely upon a species that is directly affected. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption (USEPA 2011). The dicamba risk assessment addendums (USEPA 2016c, 2016d, 2016e) conclude no indirect effects to endangered or threatened (listed) species based on mitigation measures to limit spray drift exposure to only soybean and cotton fields based on

species biology and species proximity. Indirect effects to non-listed species would be limited to those species that rely on other non-listed species for food, habitat, or other resources (USEPA 2011, USEPA 2016a). By requiring pesticide application restrictions that limit off-site exposure to levels below effects thresholds of the most sensitive taxonomic group, the action area (the geographic extent to where effects can reasonably be expected to occur), is limited to the treated field. EFED's assessment determined that no direct or indirect effects are expected for listed species within the action area (USEPA 2016c, 2016d, 2016e).

Comment: EPA did not adequately address risk concerns from runoff.

Response: EPA disagrees that the Agency did not adequately address potential risk concerns from runoff for this dicamba decision. EPA acknowledges that these public comments on the risk assessment and effects determination pointed out that the EPA did not explicitly include a consideration of the risk findings for non-target plants as a result of off-field runoff in the soybean new use assessment (USEPA 2011); however, the 2016 cotton new use assessment (USEPA 2016a) included a more extensive discussion concerning runoff. EPA refers the commenters to that analysis, found on pages 33 and 34 of the 2016 cotton new use assessment (USEPA 2016a). Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass. Using these assumptions in TerrPlant (total 2 lb ac/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48) (USEPA, 2016a). The runoff risk findings of the cotton new use assessment (USEPA 2016a) are also applicable to the soybean assessment (USEPA 2011).

Comment: The risk assessment analyses did not follow the National Academy of Sciences (NAS) recommendations. The assessment dismissed risks, even when risk quotients were above the level of concern and failed to come to a "may affect" conclusion, when any risk concerns were identified.

Response: EPA agrees it did not follow the NAS recommendations when evaluating whether the dicamba formulation would affect listed species. However, EPA's determination of "no effect" (USEPA 2016c, 2016d, 2016e) was based on a scientifically valid methodology consisting of an ecological risk assessment conducted in accordance with EPA guidance at the time of drafting the risk assessment and consistent with the methods described in the "Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency: Endangered and Threatened Species Effects Determinations," Office of Pesticide Programs 2004 Overview Document. This assessment

included a problem formulation describing the nature of the Federal action, an assessment of potential pesticide exposure, an assessment of the toxicological hazards associated with the pesticide, and a risk characterization that integrated all available lines of evidence to support the effects characterization for each taxonomic group and species. Moreover, in situations where there was a potential taxonomic concern, the EPA used available U.S. Fish and Wildlife Service information (*i.e.*, Species Recovery Plans, Species 5-Year Reviews) to conduct focused assessments for individual species.

The National Academy of Sciences' (NAS) report was issued in 2013, two years after the screening-level ecological assessment for dicamba use on dicamba-tolerant soybeans was finalized. EPA and the U.S. Fish and Wildlife Service and the National Marine Fisheries Service have adopted a “day forward” approach for endangered species risk assessments that will begin once consensus is reached on the risk assessment methodology and process. Thus, the analyses used in the dicamba DGA risk assessment addendums (USEPA 2016c, 2016d, 2016e), use a combination of “old” methods alongside some tools² that are being considered for the revised endangered species risk assessment approach.

The assessment process employed in the effects determination is composed of three parts: (1) the original screening-level assessment conducted under the provisions of the Overview Document, (2) a plant endpoint/spray drift addendum that further characterized plant endpoints taking into account all available toxicological information, and (3) an endangered species risk assessment addendum that used the results of the screening risk assessment, drift effects addendum and information on the biology (*e.g.* food requirements and habitat needs) for each listed species within the proposed action area to determine if pesticide exposure would have a direct or indirect effect on each species.

The screening-level assessment (USEPA 2011) considered risks to all non-target taxonomic groups of organisms in a manner consistent with the pre-NAS risk assessment process used to support effects determinations. That process uses available environmental fate and effects information to make preliminary determinations of whether conservative estimates of pesticide exposure would raise concerns for one or more taxonomic groups. The screening-level assessment results suggested that, should actual exposures occur, direct effects may be possible for listed mammals, birds, reptiles, land-phase amphibians, and terrestrial plants (risk quotients were above the level of concern). However, additional information related to specific species within these taxonomic groups was needed to ascertain if species biology, geography and timing would lead to a determination that exposures would reasonably occur for these organisms. Additional information included: species specific biology, geographic location, and the ability of spray drift mitigation measures to reduce the geographic extent of exposures of concern to a limit of the boundaries of the treatment site. When these types of information were considered, the endangered species assessment addendums concluded that there were no direct risk concerns for mammals, birds, reptiles, land-phase amphibians, and terrestrial plants with the exception of the

² <https://www.epa.gov/endangered-species/provisional-models-endangered-species-pesticide-assessments>

Spring Creek Bladderpod (for which a “may affect, likely to adversely affect” determination was made for Wilson County, TN), the Eskimo curlew (where the determination was “may effect, not likely to adversely affect” in 23 NE counties and one TX county based on informal consultation with the USFWS) and the Audubon’s crested caracara (where a “no effect” determination was made for soybean, and a “no effect” determination was made for cotton in all counties except Palm Beach County, FL, where a “may affect, not likely to adversely affect” is the conclusion). (USEPA 2016c, 2016d, 2016e). Subsequent to these assessments, the registrant submitted amended labeling (and EPA approved) that off-labels these counties. Therefore, there are no “may effect” determinations for this registration action.

EPA’s assessment was also consistent with its statements in the November 2014 *Interim Report to Congress on Endangered Species Act Implementation in Pesticide Evaluation Programs* (submitted by EPA, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the U.S. Department of Agriculture), “EPA intends to complete Overview Document-compliant endangered species assessments for new herbicide tolerant crop uses.” See <https://www.epa.gov/sites/production/files/2015-07/documents/esareporttocongress.pdf> at page 22. Consistent with this Report, EPA conducted a species-specific endangered species assessment for the use of dicamba on the GE soybean and GE cotton crops. (USEPA 2016c, USEPA 2016d, USEPA 2016e). These new uses will also be reassessed along with all the other registered uses for the active ingredient dicamba during the Registration Review process.

Comment: Commenters disagreed with EPA’s process used to reach a “no effects” determination for threatened and endangered species.

Response: In conducting the effects determinations, EPA used the most sensitive taxonomic group effects thresholds to establish the extent to which effects were possible (USEPA 2014). This approach is consistent with both the Overview Document approach and the NAS approach for defining the action areas of the proposed Federal action, when spray drift mitigation measures were taken. Mitigation steps were incorporated into modifications of the proposed Federal action and were incorporated into the screening-level risk assessment that was used as a quantitative input to the effects determinations. Environmental exposures, taking into account the mitigation measures on the approved labeling (USEPA 2014), were concluded to be below effects thresholds – the no effect threshold for the most sensitive taxa for areas off the field. This limited the action area to within the bounds of the specific target crop application sites for the pesticide product. Using the process outlined in the Overview Document for the remaining species within the action area, the EPA conducted additional exposure and effects assessment and biological evaluation (USEPA 2016c, 2016d, 2016e), specific to those species, to determine if effects would occur for those species and to assess whether habitat utilization of the cropped areas was such that herbicide application would result in species relevant effects. See also the comment response on runoff. *See also* the previous comment and response.

Comment: The number of uncertainties in the risk assessment reduces the confidence in its conclusions.

Response: EPA believes that despite uncertainties, the conservative nature of the exposure and hazard evaluations, such as the assumption that animals forage exclusively on the treated crop, as well as the careful consideration of species biology and habitat uses, are sufficient to conclude that the assessment is reasonable.

III. Resistance Management

Comment: Overuse of Dicamba can lead to resistant weeds.

Response: The Agency agrees that, without a robust resistance management program, widespread use of dicamba can select for weed species that can survive dicamba applications and reproduce. EPA is requiring a number of elements in the terms and conditions of registration to help slow the development of dicamba resistant weeds, such as: resistance management training materials and plans, remedial action plans (in case resistant weeds are thought to be present in a field), and the reporting of likely resistant weeds. See the document, “Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean” in this docket, for details. In addition to requiring a resistance management plan, the registration being granted is a time limited registration in case problems such as herbicide resistance weeds are identified and need to be addressed.

Comment: Control of Herbicide Resistant Weeds: Dicamba resistant cotton and soybean crops can be an effective tool for managing herbicide resistant weeds. It makes available another effective mechanism of action, it can be used in support of conservation tillage systems, and can be incorporated into an integrated pest management plan.

Response: The Agency agrees with the comment. As described in its benefits analysis, the EPA finds that the registration of dicamba, for in season use on dicamba herbicide resistant cotton and soybean, would provide weed control benefits to growers if properly incorporated into an integrated pest management plan that includes specific measures to manage herbicide resistant weeds. An additional tool for resistance management is important because both cotton and soybean have a number of different broad-leaf weed species resistant to multiple different mechanisms of action (12 and 27 weed species respectively). This would be a new mechanism of action for cotton. This would not be a new mechanism of action for soybeans because there are two auxin herbicides, 2,4-D and 2,4-DB, registered on soybeans, which have similar modes of action to dicamba. Dicamba can be used in support of conservation tillage systems, and can be incorporated into an integrated pest management plan.

Comment: The proposed label allows up to 4 applications of dicamba per year. The Agency should limit dicamba applications to 2 per year to reduce the risk of developing herbicide resistant weeds. Another commenter recommended that the Agency should further limit the frequency with which dicamba is applied to once per season.

Response: The Agency agrees that dicamba resistant weeds are of high concern, and that limiting the number of dicamba applications per year could reduce the potential to select for dicamba resistant weed species. However, the Agency also recognizes the need for flexibility in a weed management system. Weeds can vary in terms of germination pattern and timing, necessitating additional applications in some cases to allow for adequate control. Varying weather conditions can also affect weed growth patterns, further necessitating flexibility in the timing and number of applications for effective control. There is a rigorous resistance management plan that is part of this decision that EPA believes will be effective to reduce the potential for development of resistance (see “Final Registration of Dicamba on Dicamba Tolerant Cotton and Soybeans” in this Docket). If, at the end of the expiration term of the registration, it appears that adjustments are needed to address resistance issues, the terms of registration and labeling can be reconsidered.

Comment: Leaving a buffer allows weeds to grow and produce seed. The proposed decision of 2016 calls for in-field buffers of 110 to 220 feet on all four sides of the field to protect crops from drift and volatility.

Response: EPA agrees that in-field buffers where dicamba cannot be used can create areas in which weeds develop and set seed. However, these in-field buffers are designed to protect adjacent areas from off-site movement of dicamba. This can also occur when weeds develop and set seed in areas adjacent to fields because it is not possible for the grower to control them. Growers will need to use a combination of cultural, mechanical, and chemical (including soil residual as well as post-emergence herbicides) methods to control weeds in the in-field buffers or choose to grow other crops with different weed control options in fields heavily infested with herbicide resistant weeds. After review of new data, EPA determined that the in-field buffers will only be required on the downwind side of the application. Based on field volatility (flux) studies (conducted in accordance with the draft label conditions such as nozzle and ground speed limitations) and laboratory vapor-phase toxicity and exposure (humidome) studies, the vapor-phase exposure of plants to the dicamba DGA (M-1691) and dicamba DGA plus VaporGrip™ (M-1768) formulations are not of concern off the treated field. The new data show that exposures from volatility will be below the LOC defined by our apical-endpoint based NOEC. Therefore, the 110-foot omnidirectional buffer for volatilization is no longer necessary even when accounting for the uncertainties in the field data. However, the in-field spray drift buffer of 110 feet (220 feet for application rates of 44 oz product/A) downwind at the time of application must be maintained, because spray drift remains the main concern for off-site exposure.

Comment: The introduction of dicamba resistant cotton will compromise boll weevil eradication efforts because dicamba will no longer be effective for control of volunteer cotton and cotton stalks.

RESPONSE:

The EPA does not think that dicamba resistant cotton will compromise boll weevil eradication efforts. There are a number of methods to control boll weevil (*Anthonomus grandis*) in cotton producing areas. Cultural control methods include shredding, or plowing (when allowed) of cotton residue, or flood irrigation³, early planting of the crop before boll weevils are active, and avoiding excess fertilizer and irrigation so the crop is less attractive to the insect. Monitoring using pheromone traps should also be conducted to allow early detection of the adults. If the boll weevil is detected during the season applications of malathion are recommended. If volunteer cotton is a problem there are fifteen herbicides within 6 different mechanisms of action recommended for its control⁴ including: carfentrazone (Group 14), 2,4-D (Group 4), dicamba (Group 4), diflufenzopyr (Group 19), flumioxazin (Group 14), fluthiacet-methyl (Group 14), fomesafen (Group 14), lactofen (Group 14), glyphosate for use on non glyphosate-resistant cotton (Group 9), glufosinate for use on non glufosinate-resistant cotton (Group 10), paraquat (Group 22), pyraflufen-ethyl (Group 14), saflufenacil (Group 14), and thifensulfuron plus tribenuron (Group 2 + 2).

Comment: Commenters stated concerns regarding the 11 elements for herbicide resistance management plans, as well as suggestions for developing multiple ways to report likely resistance and differentiate non-performance.

Response: The 11 elements for herbicide resistance management plans are generic recommendations, intended to apply to all herbicides. These generic recommendations are being addressed separately from this action on dicamba. The Agency will address comments on the generic elements during the review of the draft guidance for pesticide registrants on herbicide resistance management labeling, education, training, and stewardship (FRL #: 9946-53 and OCSPP Docket #: OPP-2016-0226) available online at <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2016-0226>). For this dicamba action, the resistance management elements that are relevant are discussed in Section V of the document entitled, “Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean,” which is available in the Docket associated with this action (EPA-HQ-OPP-2016-0187).

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<http://www.texasagriculture.gov/RegulatoryPrograms/CottonStalkDestruction/CottonStalkDestructionMethods.aspx>

⁴ http://publications.tamu.edu/COTTON/PUB_cotton_Managing%20Volunteer%20Cotton%20in%20Cotton.pdf

IV: Other Concerns

Crop rotational restrictions: Commenter(s) expressed concern that 120 days after application before planting corn is not a reasonable rotational interval for corn. Corn can be planted immediately after dicamba treatment without concern for crop injury. This restriction severely limits the ability to use dicamba to control glyphosate-resistant broadleaf weeds prior to corn planting.

Response: The rotational intervals specified on the label are based on data regarding residues of dicamba in the subsequent crop. These residues are important in consideration of whether tolerances need to be established for dicamba in these subsequent crops under section 408 of the Federal Food, Drug, and Cosmetic Act (FFDCA). Data regarding the nature of the dicamba residue in rotational crops were previously reviewed. It was concluded that limited and/or extensive field accumulation studies with dicamba were not necessary, and rotational crop tolerances need not be established, provided the registrants amended all dicamba labels to specify a 120-day plant-back interval (PBI) when dicamba is applied at a maximum seasonal rate of 0.75 lb ae/A or less. At application rates of 0.75-2.0 lb ae/A, only crops with established dicamba tolerances can be planted in the previously-treated field.

Sprayer Cleanout Concerns: It is difficult to remove dicamba residues from the tank after spraying, leading to concerns about subsequent cross-contamination.

Response: EPA understands this concern and has addressed it by requiring that the labeling have the following language regarding cleaning of equipment:

Proper spray system equipment cleanout

Minute quantities of dicamba may cause injury to non-dicamba-tolerant soybeans and other sensitive crops (see the “Sensitive Areas” section of this label for more information). Clean equipment immediately after using this product, using a triple rinse procedure as follows:

1. After spraying, drain the sprayer (including boom and lines) immediately. Do not allow the spray solution to remain in the spray boom lines overnight prior to flushing.
2. Flush tank, hoses, boom and nozzles with clean water.
3. Inspect and clean all strainers, screens and filters.
4. Prepare a cleaning solution with a commercial detergent or sprayer cleaner or ammonia according to the manufacturer’s directions.
5. Take care to wash all parts of the tank, including the inside top surface. Start agitation in the sprayer and thoroughly recirculate the cleaning solution for at least 15 minutes. All visible deposits must be removed from the spraying system.
6. Flush hoses, spray lines and nozzles for at least 1 minute with the cleaning solution.
7. Repeat above steps for two additional times to accomplish an effective triple rinse.

8. Remove nozzles, screens and strainers and clean separately in the cleaning solution after completing the above procedures.
9. Appropriately dispose of rinsate from steps 1-7 in compliance with all applicable laws and regulations.
10. Drain sump, filter and lines.

Rainfall Restriction: Several commenters expressed concern about the 24-hour rainfall restriction (“Do not make application of this product if rain is expected within 24 hours”), and indicated that dicamba is rainfast in less than 24 hours, making a shorter rainfall restriction time appropriate.

Response: The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted concentrations from modeling were lower than the most sensitive taxa’s endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and the fact that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a “no effects” determination for runoff exposure for off-field plants listed as threatened or endangered under the Endangered Species Act (ESA) for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would further protect against the risk of exposure to listed species off the treated field. 24 hours is the standard timing of such mitigation. If formulation-specific data are available to demonstrate that the rainfastness of this formulation is less than 24 hours, the Agency would consider revising this restriction.

Enforceability/compliance with restrictions on label: Several commenters expressed concern that applicators will not comply with the restrictions on the label.

Response: The restrictions on the label were developed to protect threatened/endangered species, and to meet the FIFRA standard of no unreasonable adverse effects to humans and the environment. Failure to comply with the label is a violation of Federal law. EPA expects that users will comply with the labeling requirements and the Agency works with the states to enforce labeling requirements. EPA also has incorporated conditions in this registration to provide additional precautions. The terms of registration require Monsanto to develop and implement an education program that will provide growers with the best available information on herbicide resistance management. Additionally, this registration automatically expires two years after issuance unless EPA determines before that date that off-site incidents are not occurring at unacceptable frequencies or levels. If this automatic expiration date is amended (in whatever way EPA determines is appropriate at the time), it shall not be amended to a date later than 5 years after issuance, by which date this registration will automatically expire unless EPA determines before that date that herbicide resistance to dicamba is not occurring at unacceptable frequencies or levels, and that off-site incidents are not occurring at unacceptable frequencies or levels.

Label Comparability Across Dicamba Formulations:

Comment: Commenters expressed concern that the proposed label includes much more information and restrictions than other formulations of dicamba on the market.

Response: The Agency has evaluated the information pertinent to the action at hand, namely the new uses of the M 1768 formulation of dicamba for use on dicamba-tolerant soybean and cotton. The label language has been developed based on these analyses. However, all dicamba products are currently undergoing registration review, during which all data will be considered, and the Agency may revise those labels or take additional regulatory action as necessary.

General Label Comments/Questions:

The Agency received numerous comments about individual sections of the product label. The Agency has considered these comments in developing final labeling that it feels provides protective measures in clear and enforceable terms. The final approved product label is discussed in the Final Decision (Final Registration of Dicamba on Dicamba Tolerant Cotton and Soybeans) and may be found in Docket EPA-HQ-OPP-2016-1087.

Several commenters pointed out typographical errors on the proposed labels. The Agency appreciates this, and has corrected them on the final approved labels.

Comment: Concern/question regarding the need to check the approved list of adjuvants within 7 days of application.

Response: The website referred to on the label, which will contain the list of approved adjuvants, is intended to be continually updated. In order to ensure that the applicator is using adjuvants which are approved at the time of application, the list should be checked within 7 days of the application.

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Appendix I: Response to Center for Food Safety (CFS) Comments on Human Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean, section “Human evidence”

The portion of the Center for Food Safety (CFS) document that concerns epidemiology data (pages 31 – 32) is copied below in **left aligned, standard font**, with EPA responses by sentence in indented, alternate font underneath the referent CFS text.

In this attachment and in the accompanying memorandum, EPA limited its responses to CFS comments in the CFS document section “Human evidence” that specifically addressed epidemiological evidence investigating a relationship between dicamba exposure and an associated health outcome. If a comment or reference in the CFS document did not refer to a published article that investigated dicamba exposure and a specific health outcome, EPA considered the CFS comment or reference beyond the scope of this attachment and the overall article statements in the accompanying memorandum.

Human evidence

Epidemiological studies have associated dicamba exposure with increased incidence of a number of cancers in pesticide applicators. In 1992, epidemiologists with the National Cancer Institute (NCI) found that Iowa and Minnesota farmers who were first exposed to dicamba prior to 1965 had increased incidence of non-Hodgkin’s lymphoma (NHL) relative to controls, with an odds ratio of 2.8.¹⁴⁸

148 = Cantor et al. 1992

Response to CFS: While elevated, the ORs were not statistically significant (encompassed the null value of 1.00⁵). Furthermore, the case and controls numbers were quite small.

Cantor et al. 1992: “Among the herbicides marketed prior to 1965, use before 1965 of chloramben and dicamba was significantly associated with total NHL.”

⁵ For odds ratios (ORs), risk ratios (RRs), and hazard ratios (HRs), the confidence interval (CI) acts as a proxy for significance testing, with CIs that do not contain the null value (OR / RR / HR = 1.00) considered significant.

EPA response: The numbers were reported as OR = 2.8 (0.96, 8.1) with 7 cases and 7 controls exposed to dicamba prior to 1965. We do not consider this statistically significant as the CI encompassed the null value of 1.00. Furthermore, the case and control numbers were very low (N = 7).

Cantor et al. 1992: "The pesticides with OR greater than 1.5 in both states were: the insecticides chlordane, lindane, and malathion applied to livestock; the insecticides carbaryl, DDT, diazinon, and malathion applied to crops; and the herbicides chloramben and dicamba."

EPA response: The numbers were reported as:

Iowa only: OR = 2.1 (0.6, 8.1) (4 cases, 5 controls)

Minnesota only: OR = 3.9 (0.6, 24) (3 cases, 2 controls)

We do not consider this statistically significant as the CI encompassed the null value of 1.00. Furthermore, the case and control numbers were very low.

Further data reported in Cantor et al. 1992:

OR = 1.2 (0.7, 2.0) ever handled (28 cases, 57 controls)

OR = 1.4 (0.8, 2.5) handled without PPE (19 cases, 32 controls)

EPA response: We do not consider these results statistically significant as the CIs encompassed the null value of 1.00.

A subsequent study in Canada also found an association between exposure to dicamba and NHL.¹⁴⁹

149 = McDuffie et al. 2001

Response to CFS: Additional studies, preferably in different populations by different researchers, investigating associations between dicamba and NHL are necessary to corroborate the findings of this article to provide sound evidence of a causal association between dicamba and NHL⁶. In the absence of additional studies corroborating

⁶Causality as defined by the Bradford-Hill criteria: strength of association, consistency of evidence, specificity of the association, temporality, dose-response, biological plausibility, and coherence with established knowledge. Via Hill, Austin Bradford. "The environment and disease: association or causation?." Proceedings of the

these findings, we consider these results alone as elements of evidence, but not sufficient evidence, of an association between dicamba and NHL.

McDuffie et al. 2001: "We found that among major chemical classes of herbicides, the risk of NHL was statistically significantly increased by exposure ...to dicamba (OR, 1.88; 95% CI, 1.32-2.68)."

EPA response: The OR showed evidence of a positive association and the CI was significant. These results reflected 517 NHL cases (73 exposed) and 1,506 controls (131 exposed). Additional data from table 2:

- OR = 1.92 (1.39-2.66) (calculated with strata for the variables of age and province of residence)
- OR = 1.88 (1.32-2.68) (adjusted for statistically significant medical variables (history of measles, mumps, cancer, allergy desensitization shots, and a positive family history of cancer in a first-degree relative), and with strata for the variables of age and province of residence)
- Sub analysis of individual dicamba herbicides:
 - OR = 1.59 (0.95-2.63) with 26 cases/50 controls exposed to "Dicamba (Banvel or Target)" (calculated with strata for the variables of age and province of residence)
 - OR = 1.6 (1.0-2.6) with 26 cases/50 controls exposed to "Dicamba (Banvel or Target)" (adjusted for statistically significant medical variables (history of measles, mumps, cancer, allergy desensitization shots, and a positive family history of cancer in a first-degree relative), and with strata for the variables of age and province of residence)
 - EPA response to sub analysis of individual dicamba herbicides: While ORs were elevated, they were not statistically significant because the CIs encompassed the null value

McDuffie et al. 2001: "In multivariate analyses, the risk of NHL was statistically significantly increased by exposure to... dicamba (OR, 1.68; 95% CI, 1.00 -2.81)."

EPA response: While the OR was elevated, it was not statistically significant because the CI encompassed the null value of 1.00.

McDuffie et al. 2001: "In additional multivariate models, which included exposure to other major chemical classes or individual

pesticides, personal antecedent cancer, a history of cancer among first-degree relatives, and exposure to mixtures containing dicamba (OR, 1.96; 95% CI, 1.40 -2.75) or to mecoprop (OR, 2.22; 95% CI, 1.49-3.29) and to aldrin (OR, 3.42; 95% CI, 1.18 -9.95) were significant independent predictors of an increased risk for NHL"

EPA response: The OR showed evidence of a positive association and the CI was significant.

A study of cancer in Iowa farmers associated exposure to benzoic herbicides¹⁵⁰ with increased risk of multiple myeloma,¹⁵¹ which has since been identified as a subtype of non-Hodgkin's lymphoma.¹⁵²

150 = Not an epidemiology study reference. From text footnotes:

¹⁵⁰ Dicamba is the most widely used benzoic acid herbicide.

Response to CFS: No epidemiology response required.

151 = Burmeister 1990

Response to CFS: A text search of Burmeister 1990 found no specific investigation of dicamba. No epidemiology response required.

152 = Schinasi and Leon 2014 (discussed below)

A comprehensive meta-analysis of epidemiology assessing non-Hodgkin's lymphoma and exposure to agricultural pesticides also found an association with dicamba exposure.¹⁵³

153 = Schinasi and Leon 2014

Response to CFS: While the meta-analytic summary RR was elevated, it was not statistically significant (encompassed the null value of 1.00). Furthermore, the meta-analysis was run on just two studies considering

the association between dicamba and NHL (McDuffie 2001 and DeRoos 2003) .

Authors reported meta-analytic summary RR estimate (CI) = 1.4 (1.0 2.1); I^2 (inconsistency) = 0.0%.

- Schinasi and Leon 2014: "Because we identified a variety of sources of heterogeneity between papers, we decided a priori to calculate meta- risk ratio (RR) estimates and 95% confidence intervals (CIs) using random effect models, allowing between study heterogeneity to contribute to the variance... We report I^2 values, which represent the percentage of the total variance explained by study heterogeneity and measure inconsistency in results. Larger I^2 values indicate greater inconsistency"

The two studies incorporated into the meta-analysis were:

- 1) McDuffie et al. 2001
- 2) De Roos et al. 2003

Exposure to pesticides has long been suspected as a risk factor in non-Hodgin's [sic] lymphoma due to a striking fact. While farmers are generally healthier, and have lower *overall* cancer rates than the general population, they have higher than average risk of contracting NHL and several other cancers.¹⁵⁴

154 = Blair and Zahm 1995

Response to CFS: A text search of Blair and Zahm 1995 found no specific investigation of dicamba. No epidemiology response required.

This fact lends weight to epidemiology studies that find correlations between these cancers and and [sic] specific pesticides, such as dicamba. EPA does not discuss the increased incidence of NHL or any other cancer in farmers or pesticide applicators.

EPA fails to assess these studies, though CFS brought most of them to the Agency's attention several years ago.¹⁵⁵

155 = From text footnotes:

¹⁵⁵ See Exhibit B (attached).

Response to CFS: Not a specific study investigating a relationship between dicamba exposure and an associated health outcome and therefore beyond the scope of this attachment. No epidemiology response required.

Neither does EPA remark on or assess the commonality in cancer type (lymphatic system) in animal experiments and epidemiology: malignant lymphomas (male rats), lymphosarcomas (female mice), and non-Hodgkin's lymphoma (pesticide applicators). This may well indicate that dicamba has a common mechanism of action targeting the lymphatic system in animals and humans.

The only epidemiology study assessed by EPA in its six-sentence treatment of epidemiology data. [sic]¹⁵⁶ is from the Agricultural Health Study [sic]¹⁵⁷

156 = Not an epidemiology study reference. From text footnotes:

¹⁵⁶ EPA, *Human Health Risk Assessment*, at 29-30

Response to CFS: No epidemiology response required.

157 = Samanic et al. 2006 (discussed below)

Samanic et al. found found [sic] suggestive associations between dicamba exposure and both lung and colon cancer, with statistically significant exposure-response trends in both cases.¹⁵⁸

158 = Weichenthal et al. 2010

Response to CFS: The review article by Weichenthal et al. 2010 discussed results from Samanic et al. 2006 and Alavanja et al. 2004, which were both addressed separately in this memo attachment. Weichenthal et al. 2010 did not contribute original data or additional analyses; therefore, we did not respond to Weichenthal et al. 2010 directly.

EPA's cursory review of Samanic et al. (2006) is biased, incomplete and erroneous, failing to report even the specific types of cancer – lung and colon – for which the authors found dicamba dose-response trends when the referent group was low-exposed applicators.

Points raised by CFS with respect to Samanic et al. 2006 are addressed by sentence below. **One CFS comment, that EPA failed to identify the cancer site for the reported p-trend, is a valid critique. Furthermore, we feel that EPA should have reported additional significant findings from Samanic et al. 2006 in its previous document.**

Samanic et al. 2006 described a cohort study of 41,969 male pesticide applicators and investigated the association of health outcomes with dicamba exposure. In the abstract, Samanic et al. 2006 stated: "Although associations between exposure and lung and colon cancer were observed, we did not find clear evidence for an association between dicamba exposure and cancer risk."

Samanic et al. 2006 findings included: (Tables 2 & 3)

COLON CANCER:

Lifetime exposure days:

Using no exposure group as the referent (17 cases), RR = 1.42 (0.78 - 2.58) with 17 cases exposed in the highest exposure group (≥ 116 lifetime exposure days).

P for trend = 0.10

Using low exposure group as the referent (1 - <20 lifetime exposure days with 9 cases), RR = 3.29 (1.40 - 7.73) with 17 cases exposed in the highest exposure group (≥ 116 lifetime exposure days).

P for trend = 0.02

Intensity weighted lifetime exposure days (IWLD):

Using no exposure group as the referent (76 cases), RR = 1.76 (1.00 - 3.07) with 20 cases exposed in the highest exposure group (≥ 739.2 IWLD).

P for trend = 0.02

Using low exposure group as the referent (1 - <86.6 IWLD with 16 cases), RR = 2.57 (1.28 - 5.17) with 20 cases exposed in the highest exposure group (≥ 739.2 IWLD).

P for trend = 0.002

EPA reports that they found a significant trend ($p = 0.02$), failing to specify this trend was between dicamba exposure and lung cancer.

Quote from EPA document "Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology" (November 10, 2015): "More specifically: no statistically significant associations were seen using intensity-weighted lifetime exposure days and the "No exposure" group as a referent category. While a trend was apparent ($p = .02$), none of the individual point estimates was significantly elevated and the authors state that this result is due largely due to elevated risk at the highest exposure level."

Response to CFS: The CFS critique that EPA did not specify the cancer site for the reported trend is valid.

Contrary to EPA, this lung cancer trend was not "largely due to elevated risk at the highest exposure level." The authors identified a still more significant trend for colon cancer ($p = 0.002$), and it is this trend that was largely due to elevated risk at the highest exposure level.

We think this critique refers to the following quote in the EPA document "Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology" (November 10, 2015): "More specifically: no statistically significant associations were seen using intensity-weighted lifetime exposure days and the "No exposure" group as a referent category. While a trend was apparent ($p = .02$), none of the individual point estimates was significantly elevated and the authors state that this result is due largely due [sic] to elevated risk at the highest exposure level." (Emphasis added)

While the EPA document did not specify the cancer site for the trend reported in the sentence quoted above, Table 3 of Samanic et al. 2006 listed p trend = 0.02 for intensity weighted lifetime days of exposure (IWLE) for colon cancer using the no exposure group as the referent and p trend = 0.002 using the low exposure group as the referent. In the abstract, Samanic et al. 2006 stated: "We also observed significant trends of increasing risk for colon cancer for both lifetime exposure days and intensity-weighted lifetime days, although these results are largely due to elevated risk at the highest exposure level" (emphasis added). Thus, the EPA quote above could be interpreted as referencing IWLE analyses for colon cancer, not lung cancer, and thus correctly reporting the author's conclusion that the highest exposure levels drove the significant trend.⁷

Samanic et al. 2006 stated in the abstract: "When the reference group comprised low exposed applicators, we observed a positive trend in risk

⁷ Contrary to the statement from the previous EPA document ("none of the individual point estimates was significantly elevated..."), we note the statistically significant elevated RR for the highest exposure group in the IWLE analysis for colon cancer using the low exposure group as the referent (RR = 2.57; CI: 1.28-5.17 with 20 exposed cases and 16 exposed controls).

between lifetime exposure days and lung cancer ($p = 0.02$), but none of the individual point estimates was significantly elevated" (emphasis added). While we feel this trend should have been reported in the EPA document "Dicamba: Tier I (Scoping) Review..." (November 10, 2015), we consider this positive trend for lung cancer as weak evidence of any association, since the point estimates for each exposure group were not significant and the trend was not seen in any other analyses for lung cancer and dicamba including analyses using the no exposure group as the referent and analyses considering IWLE.

Samanic et al. describe their results in part as follows:

"When the reference group comprised low-exposed applicators, we observed a positive trend in risk between lifetime exposure days and lung cancer ($p = 0.02$), but none of the individual point estimates was significantly elevated. We also observed significant trends of increasing risk for colon cancer for both lifetime exposure days and intensity-weighted lifetime days, although these results are largely due to elevated risk at the highest exposure level."

EPA also fails to assess a previous Agricultural Health Study¹⁵⁹ that likewise found "a positive trend in risk for lung cancer with lifetime exposure days for dicamba..." (as quoted in Samanic et al. 2006).

159 = Alavanja et al. 2004

Response to CFS: The inconsistent results from this study provided little evidence towards an association of dicamba and lung cancer.

Alavanja et al. 2004: "Three other pesticides including dicamba, an herbicide, and two insecticides, carbofuran and dieldrin, exhibited an increasing lung cancer risk with increasing lifetime days of use when the "low-exposure" group was used as the referent group but not when the "nonexposed" group was used as the referent group. These significant trends with lung cancer risk were observed after controlling for cigarette smoking, age, and other potential confounding risk factors."

EPA response: A positive trend was seen in analyses that considered only low to high exposure ($p = 0.04$) but not in analyses that also considered no exposure (p trend = 0.15). Significant positive associations between dicamba was seen in only one analysis: the highest exposure group ($n = 8$ exposed cases) when the low exposure group was the referent (21 exposed cases). This was not seen in other point estimates, nor in the OR for the highest exposure group when the no

exposure group was the referent (95 exposed cases). The inconsistency in these results makes drawing a conclusion about associations difficult.

Alavanja et al. 2004 Table 4 reported the following: In analyses that considered the low dose group (<24.5 LEDs; 21 exposed cases) as the referent group, only the highest lifetime exposure days group (> 224.7 LEDs) exhibited a positive association (OR = 3.1 (95% CI:1.2, 7.7) with 8 exposed cases), while the other exposure groups (24.5-108.5 which had 19 exposed cases and 108.6-224.7 LEDs which had 8 exposed cases) were not significant using the low dose group as the referent. There was a statistically significant trend (p trend = 0.04).

When the "no exposure" group (LEDs = 0) was the referent, no exposure groups showed significant associations and there was no evidence of a trend (p trend = 0.15).

Alavanja et al. 2004 noted that in analyses that considered "no exposure" as the reference, the lowest exposure group (<24.5 LEDs; 21 exposed cases) showed evidence of decreased risk (OR = 0.7; 0.4-1.1).

While the OR was decreased, it was not statistically significant because the CI encompassed the null value of 1.00. Furthermore, it was based on small case numbers.

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 12/2/2016 2:47:17 PM
To: Petrella, Carlyn [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2e2ccf3172fa4240bd064865d43d830e-Petrella, C]
Subject: here is dicamba new use proposal. alot of outside the box language
Attachments: EPA-HQ-OPP-2016-0187-0016.pdf

*Grant Rowland
Herbicide Branch
Registration Division
Office of Pesticide Programs
703-347-0254*



Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

Jack Housenger, Director
Office of Pesticide Programs

Date: 3/31/16

Summary

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing to grant an unconditional registration under Section 3(c)(5) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba on genetically-modified dicamba-tolerant cotton and genetically-modified dicamba-tolerant soybean. The proposed new uses will be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582), containing 58.1% of the active ingredient dicamba, diglycolamine salt (DGA) for pre- and post-emergence (in-crop) applications to dicamba-tolerant cotton and soybean.

The U.S. Department of Agriculture (USDA) granted deregulation status for dicamba-tolerant cotton and soybean on January 15, 2015 under the Plant Protection Act.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Proposed Product: M1691 Herbicide

Background

On April 28, 2010 and July 30, 2012, respectively, EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on genetically-modified dicamba -tolerant soybean and cotton.

Dicamba is an active ingredient that is used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The proposed new uses on cotton and soybeans would expand the current timing of dicamba applications to dicamba-tolerant soybeans and cotton. Dicamba is currently registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. The proposed use would add post-emergence (over-the-top) applications to dicamba-tolerant cotton and soybean crops.

Dicamba is a member of the Benzoic acid family of herbicides (Herbicide Resistance Action Committee (HRAC) Group 4). Dicamba works by increasing plant growth rate. Once sufficient concentration is reached, the plant outgrows its own nutrient supplies and ultimately dies.

This proposal discusses several Agency considerations of the proposed use for dicamba on dicamba-tolerant soybeans and cotton, including discussions of human health and environmental risks associated with the proposed uses. Due to the multiple forms of dicamba, EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the

assessment for human health considered data associated with the BAPMA salt of dicamba, even though this registration action is being proposed for a formulation containing only the DGA salt of dicamba. This is because the data on the BAPMA salt was relevant to the analysis and resulted in the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. On the other hand, assessments focus on effects of the DGA salt when product specific considerations are discussed. For example, to determine appropriate spray drift buffers, the Agency examined drift potential using studies conducted on the DGA salt formulation.

Proposed New Uses

Cotton

On currently registered dicamba products for use on conventional cotton, pre-emergence treatment can be made at 8 fluid ounces (0.25 lb a.e. dicamba) per acre per season. The maximum single/annual application rate proposed for use on dicamba-tolerant cotton for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use, for post-emergence (in-crop) application of dicamba for use on dicamba-tolerant cotton, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in dicamba-tolerant cotton is 64 fluid ounces (2.0 lb a.e. dicamba) per acre.

If a preplant application of 32 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for dicamba-tolerant cotton.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest retreatment interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

On currently registered dicamba products, the maximum single and maximum annual application rate allowed to both conventional and dicamba-tolerant soybeans for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use for post-emergence (in-crop) application of this product to dicamba-tolerant soybeans, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in soybeans is 32 fluid ounces (1.0 lb a.e. dicamba) per acre.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay is 14 days (R1 Growth stage).

Evaluation

In evaluating a pesticide registration application, the EPA assesses a wide variety of information on the pesticide's toxicity (*i.e.*, effects on humans and other non-target organisms), exposure (*i.e.*, where and how the pesticide is used), and environmental fate (*i.e.*, how the chemical will move in the environment) to determine the likelihood of adverse effects (*i.e.*, risk) to human health and the environment resulting from the proposed uses. Risk assessments are developed to evaluate the environmental fate of the compound as well as how it might affect a wide range of non-target organisms including humans, terrestrial and aquatic wildlife and plants. On the basis of these assessments, EPA evaluates and approves language for each pesticide label to ensure the directions for use and safety measures are appropriate to mitigate any potential risk. The pesticide's label helps to communicate essential limitations and mitigations that are necessary for public safety. Once the risks are assessed and mitigation measures have been incorporated, EPA balances any remaining potential risks against the benefits of the use of the product. EPA will grant an application if it determines that the benefits of the use of the product outweigh its risks.

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human health risk assessment for dicamba, risks were assessed in a manner that assures human health protection to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba in registered or proposed to be registered products that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data showing greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency seen with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the Agency assumes that any amount of

exposure will lead to some degree of risk. Thus, the Agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be “not likely” to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2) more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment of dicamba. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The Agency determined, based on a reviews of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, EPA assumes that any amount of exposure will lead to some degree of risk. Thus, EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainty factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and 1X for FQPA SF when applicable). The inhalation HEC/HED results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) For dicamba, there is no

evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits.

After considering the available toxicity data, EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the Agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in

the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models. Therefore, the Agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other substances. For the purposes of this Proposed Registration Decision, therefore, EPA has assumed that dicamba does not have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities.

Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the point of departure for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and proposed uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the Agency's LOC for both food and water. For the U.S. population the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being proposed for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application inhalation exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the proposed uses of dicamba on dicamba-tolerant corn and soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. Volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40 acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Results of PERFUM modeling, however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates are not of concern.

4. Spray Drift

Spray drift is always a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The proposed maximum single application rate of dicamba is 1 lb ae/A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. For the purposes of the proposed uses on dicamba, this is considered a screening level assumption since the proposed use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate 1 lb ae/A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the FFDCA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- and long-term durations via the oral, dermal, and inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and proposed use sites. Drinking water values were incorporated directly into the assessment.

The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term aggregate risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short term aggregate risks.

6. Long-term aggregate risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

7. Occupational Risk Assessment

a. Short- and Intermediate-term handler Risk

EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on genetically -modified cotton and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short and Intermediate term Post-application Risk

EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard *via* the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation post application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The Agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the Agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the Agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on dicamba-tolerant soybean and cotton is provided below. More detailed discussions can be found in the Agency documents titled, *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708)* and *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)*, and its addendums entitled, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean and Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean*. These documents are in the docket. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water

and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would likely persist; however, EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. It may reach surface water via field/site runoff, spray drift during application, and by vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however EPA does not expect DCSA to reach groundwater at levels that would be of concern. The major route of exposure to non-target organisms is likely spray drift and runoff. Also, multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury. The assessments related to these routes of exposure are described in the sections below.

3. Runoff

The Agency has considered the potential effects due to runoff, and has developed proposed mitigation to limit off-site runoff. A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following dicamba applications, likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The Agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). EPA has also determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. Based on the weight of evidence approach, EPA determined that labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (*i.e.* NOAEC for soybean plant height).

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, the Agency had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Though the Agency found the information helpful, the submission did not include enough detail to verify the measurements in the studies. Therefore, in order to be protective of potential effects to non-target plants from volatilization, labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate. Although the Agency is not requiring additional data to be submitted at this time, if EPA receives volatility data under varied conditions of temperature and relative humidity, as these factors play a strong role in volatility under field conditions, it may reconsider whether this mitigation requirement is necessary.

EPA is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being proposed by EPA (400 feet as opposed to 110 to 220 feet). EPA has reviewed the information associated with the larger buffer in Arkansas to assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (*i.e.*, plant height) for the most sensitive plant species tested (*i.e.*, soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the proposed uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are

drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the proposed label. The Arkansas Plant Board felt that a 400 foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic ($RQ = \text{Exposure} / \text{Toxicity}$). RQs are then compared to EPA's levels of concern (LOCs). The LOCs are criteria used by the Agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the Agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including cotton and soybean. The proposed uses on dicamba-tolerant soybeans and cotton would expand the timing of applications from pre-emergence and pre-harvest only for soybeans and pre-emergence and post-harvest only for cotton to allowing post-emergence over-the-top applications. The maximum yearly application rates would remain 2.0 lb a.e./acre for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./acre between pre-emergence and post-emergence applications.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad

default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations.

The results of the screening level risk assessments indicate that the RQs do not exceed the Agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the Agency's LOC. The screening level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both cotton and soybeans, based on the proposed maximum application rates, the screening level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the Agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans. Before considering mitigation measures, EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening level assessment, further refinement, as discussed below, suggest that risks are lower.

1. Risk to Birds

For birds, the screening level assessment indicated that the RQs exceeded the Agency's LOCs on an acute basis for both soybean and cotton. More specifically, the screening level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in dicamba-tolerant soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming soybean forage/hay.

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The Agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs.

Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns, suggesting that dicamba consumed in the diet may possibly be less available than assumed using dose-based exposures. Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger concerns for many food items. In addition, estimates of exposure in screening level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms with territories established at distance from the field. With this last line of evidence in mind, the draft pesticide label requires an in-field 110 to 220-foot buffer to further reduce off-site exposure for birds (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for birds feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

2. Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the Agency's LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening level assessment using the maximum exposure values from empirical datasets for DCSA residues in dicamba-tolerant soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. A screening level assessment using the maximum exposure values from empirical data for DCSA residues in dicamba-tolerant cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the draft pesticide label requires an on-field 110 to 220-foot buffer in all directions to further reduce off-site exposure for mammals (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for mammals feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an Agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the proposed uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift, and for dicots in semi-aquatic areas due to runoff and spray drift. The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that labeling restrictions will help to reduce spray drift off field. The registrant submitted additional studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and the formulation in its application for registration. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1691 herbicide when an adequate buffer is incorporated between the application equipment and the edges of the treated field.

Additionally, to further mitigate against potential risks to plants from spray drift, the product labeling requires the use of 110-220 foot (depending on application rate) buffer between the last treated row and the closest edge of the field to be treated (in all directions). The Agency considered exposure to spray drift to be the principal risk issue associated with the proposed labeled use for all taxa. EPA considered a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting.

4. Synergism

EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. In EPA's risk assessments, the Agency uses GLP guideline studies to determine potential toxicity to plants, involving apical endpoints such as biomass and reproductive health. EPA believes this approach is very reliable for these purposes. However, at this time, the topic of synergy and multiple stressors is an uncertainty in assessing risk to non-target plants including endangered

species. Therefore, EPA is proposing a tank mix prohibition on the M1691 label to address this uncertainty.

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this proposed decision.

In the screening level risk assessment performed for the new application timing of dicamba (DGA) on genetically modified cotton and soybean to be tolerant to dicamba, EPA determined that direct concerns were unlikely (*i.e.* levels of concern were not exceeded) for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <https://www.epa.gov/endangered-species/ecological-risk-assessment-process-under-endangered-species-act>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still

exceeds the Agency's levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species' habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

This registration for dicamba is being proposed for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an assessment of listed species is completed for any such state.

Based on EPA's LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), EPA identified the listed species that are inside the "action area" (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 30 states.

The following criteria were used to assess listed species in the action area:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have "no effect."
- For listed individuals outside the action area, use of a pesticide would be determined to have "no effect."
- Listed individuals inside the action area may either fall into the "no effect" or "may effect" categories depending upon their specific biological needs and circumstances of exposure.

- Those that fall under the “may effect” category are found to be either “likely” or “not likely to be adversely affected.” This determination is made in consultation with the Services
- A “likely” or “not likely to adversely affect” determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift mitigation language including a 360 degree infield buffer (to varying length, depending on application rate) on the label is intended to limit off site transport of dicamba DGA through spray drift, as well as volatilization. Therefore, EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, EPA concluded a no effect determination for all but 24 species originally identified as potentially at-risk (in the screening level assessment) because they are not expected to occur on cotton and soybean fields. The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in EPA’s refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, EPA made a determination that exposure occurring on the field would have “may affects” (either “unlikely to adversely affect” or “likely to adversely affect” on 2 species (the Spring Creek Bladderpod and the Audubon Crested Caracara) in 2 counties (Wilson county, TN and Palm Beach county, FL, respectively) within the States covered by this proposed decision. Furthermore, the Agency has concluded that the 2 species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in both counties, thus mitigating any possible chance of exposure.

Additionally, the Agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, EPA’s analysis supports a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, EPA is proposing to require rainfast mitigation on the label (“Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.”) to protect against the risk of exposure to listed species off the treated field.

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on genetically-modified crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, EPA is proposing, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a

lack of performance can communicate directly with Monsanto by a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the proposed uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label. The registrant must then evaluate the situation to determine if lack of performance is caused by resistance or likely resistance.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy^[i], et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers’ permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15th, 2018, on or before January 15th of each year, Monsanto must submit annual summary reports to EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, county and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The

annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the proposed dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The Agency received 11 comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2010-0496) for the application to register the use of dicamba on genetically-modified soybeans and no comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2012-0841) for the application to register the use of dicamba on genetically-modified cotton. The majority of comments expressed concern (e.g., spray drift and volatilization) and requested that the Agency deny the proposed registration. The EPA welcomes input from the public during the decision process when registering pesticides, and is committed to thoroughly evaluating and mitigating any potential risks from registered pesticides, consistent with applicable statutory standards. EPA considered the public comments received in this regulatory decision.

The commenters focused on spray drift and volatilization concerns affecting non-target plants. The Agency has evaluated the risks regarding the potential drift of pesticides to sensitive crops and other non-target plants that may be adjacent to treatment areas. Specific label directions and restrictions have been proposed to protect from off-target movement of this pesticide product. Specifically, the proposed registration decision requires a 110-220 foot buffer between the treated area and edge of the field in all directions. These buffers are expected to keep spray drift from moving beyond the edge of the crop field to be treated as well as reduce the concern for volatility. In addition, the label will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide to distances within these buffers. The proposed regulatory decision also specifies that this product cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. Label language regarding spray volume, equipment ground speed, and spray boom height is intended to further protect against off-target drift. More details on EPA's and Monsanto's efforts to minimize effects to non-target plant species can be found in Section VIII.B.4 of this document.

Commenters also expressed concerns that weeds resistant to dicamba will become more prevalent as a result of this proposed use. Weed resistance is an increasing problem that has become a significant economic issue to growers. In an effort to address this concern and to prevent new weed resistance from happening, while giving growers another essential tool in their integrated pest management programs, Monsanto must put into place a stewardship program to promote responsible use of the proposed product in order to minimize the potential for increased

levels of weed resistance. This plan is discussed in detail in Section V and Section VIII.B.3 of this document.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Current registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the currently registered use of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba would expand weed management options on genetically-modified cotton and soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season would target new flushes of weeds, thereby reducing populations of these weeds and particularly would help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Proposed Registration Decision

In accordance with FIFRA, EPA only registers a pesticide when it can ensure that it will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, EPA is charged with balancing the uncertainties and risks posed by a pesticide against its benefits. EPA must determine if the benefits in light of its use outweigh the risks in order for the Agency to register a pesticide.

In the case for the proposed use of dicamba on dicamba-tolerant soybeans and cotton, and in consideration of all best available data and assessment methods, EPA believes this proposed decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. The Agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some levels of concern were exceeded for certain birds and mammals that may be in the fields that would be treated. The Agency notes that these are very conservative risk estimates using screening level (worst case) assumptions, and that they most likely do not apply to the majority of the birds and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated

field. Because of these additional restrictions, EPA expects the proposed uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the Agency's levels of concern.

On the benefits side of the analysis, use of dicamba on dicamba-tolerant soybeans and cotton is expected become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of U.S. soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states stretching across the southern half of the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on dicamba-tolerant soybeans and cotton would be beneficial as it provides an effective tool to treat especially noxious weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba could help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to soybean and cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the proposed labeling restrictions will include protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

After weighing all the risks of concern against the benefits of the proposed uses, EPA finds that when the proposed mitigation measures are applied, the risks that may remain are minimal, if they exist at all, while the benefits are potentially great. Therefore, the benefits outweigh the risks and registering these uses will not generally cause unreasonable adverse effects on human health or the environment during the 5-year time limited registration being proposed (a 5-year registration is proposed so that any unexpected weed resistance issues that may result from the proposed uses can be addressed before granting an extension or EPA can allow the registration to terminate if necessary). EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(5) registration finding for the proposed uses.

A. Data Requirements

There are no outstanding data requirements required to support the registration of this action. However, data may be required in connection with registration review activities for dicamba. Those requirements would be generic to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the proposed supplemental labels unless otherwise noted below.

1. **Worker Protection** *(Although the following Worker Protection labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. **Environmental Hazards** *(Although the following Environmental Hazards labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1691™ for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call XXXXXXXX.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless in conjunction with another mode of action herbicide with overlapping spectrum.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use the Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying M1691 Herbicide. Do not use any other nozzle and pressure combination not specifically allowed by this label.

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and are impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical

air mixing. The inversion will dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

a. Buffer

Maintain a 110-foot buffer (when applying 16 fl oz of this product per acre), or a 220-foot buffer (when applying 32 fl oz of this product per acre) between the treated area and the edge of the field in all directions.

b. Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1691 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1691 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.

- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans.
- The combined total application rate from crop emergence up to 7 days pre-harvest must not exceed 64 fluid ounce (2.0lb a.e dicamba) per acre for cotton.
- All applications for both cotton and soybeans must not exceed 64 fluid ounces (2.0 lb a.e dicamba) per acre.

C. Registration Terms

EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. EPA is basing the proposed registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

Monsanto must have an Herbicide Resistance Management (HRM) Plan for M1691 Herbicide developed and approved by EPA before a final registration can be issued. The HRM Plan must focus on educating growers on the appropriate use of the M1691 Herbicide and the associated dicamba-tolerant seeds. EPA is requiring that the HRM Plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

Monsanto or its representative must investigate reports of lack of herbicide efficacy as reported by users following “scouting.” When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for “likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Additionally, Monsanto must collect material, if possible, for further testing. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if

requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures.

c. Annual Reporting of Herbicide Resistance to EPA

Monsanto must submit annual summary reports to EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, county and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

2. EPA's Continued Control over the Registration

Because the issue of weed resistance is an extremely important issue to keep under control and can be very fast moving, this registration will expire 5 years from the date of the registration issuance, unless this term is removed or modified by EPA. At the end of 5 years, EPA can work to address any unexpected weed resistance issues that may result from the proposed uses before granting an extension or allow the registration to terminate if necessary.

3. Geographic Limitation on Use of Dicamba M1691 Herbicide

EPA is proposing to issue this registration only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62.
<http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 10/25/2016 7:09:43 PM
To: Ondish, Mindy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=7b584e2dce0b4e8088832c8b237a1e8b-Mindy Ondish]
Attachments: Dicamba - Draft Final Decision - 10-21-16 bjw mlk_bjw-gwr-10-24-16.docx

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Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 6/23/2016 8:17:42 PM
To: King, Marquee [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=47fdf7cced3744a59213c331fe18d10d-Marquee King]
Subject: Dicamba RA
Attachments: Section 3 new use (cotton).pdf; Section 3 new use (soybean) addendum #1.pdf; Section 3 new use (soybean) addendum #2.pdf; Section 3 new use (soybean).pdf

Marquee.

Sorry for the delay, I had to run to a meeting. Here are the Dicamba EFED RAs. Let me know if you need or want the ESA assessments.

-Grant

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *EW* 3/24/16
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Amy Blankinship, Senior Science Advisor *AB*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II[®] XTENDFLEX[™] cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

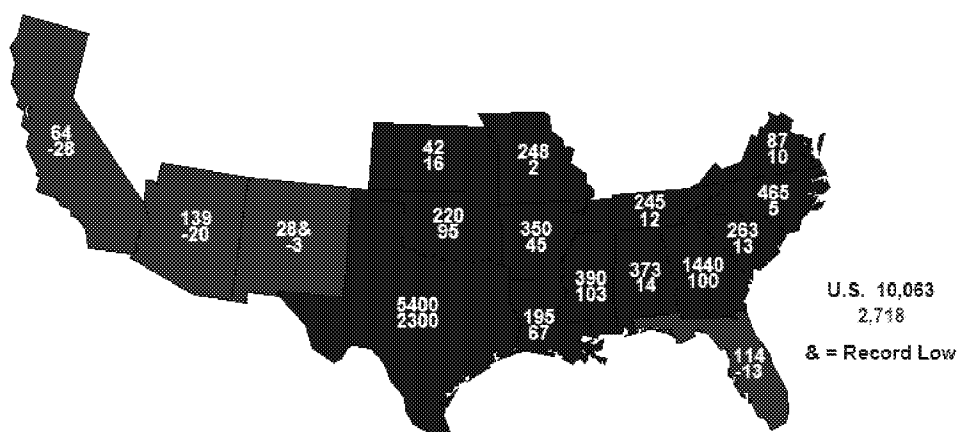
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3** and **4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and **bold italicized** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
	Arthropod	0.0143	4.19	17.58	0.24
Medium (35g)	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
	Arthropod	0.0231	2.90	14.23	0.20
Large (1000g)	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTI11004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, than given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	Seeding Rate (lbs/acre)	18.9
Seed Treatment? (Check if yes)	<input type="checkbox"/>		
Use:	cotton, all or unspecified		
Product name and form:			
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%		
Half-life (days):	8.4		
Are you assessing applications with variable rates or intervals?	yes		

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
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28		
29		
30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	
Mammalian			
Size (g) of mammal used in toxicity study	Acute Study		Chronic Study
Default rat body weight is 350 grams	350		350
Endpoint	Toxicity value	Reference (MRID)	
LD50 (mg/kg-bw)	2740.00		
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

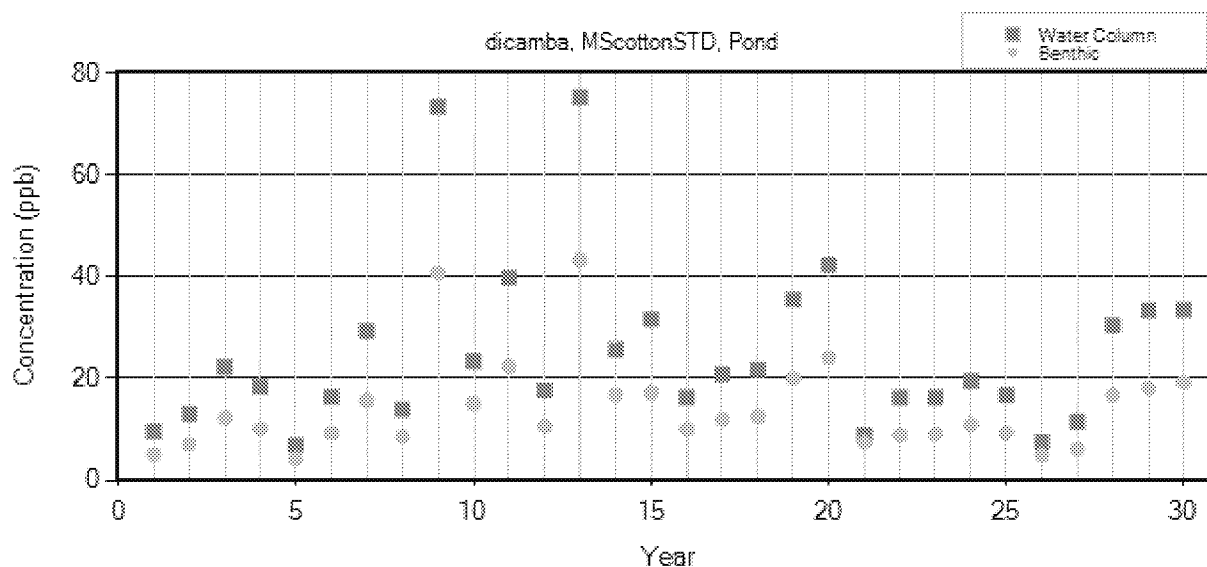


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

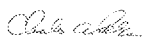
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Elizabeth Donovan
DN: cn=Elizabeth Donovan, o=EPA, ou=EFED,
email=donovan.elizabeth@epa.gov, c=US
Date: 2014.05.20 08:29:33 -04'00'
Digitally signed by Baris, Reuben
DN: cn=Baris, Reuben,
email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Mark Corbin
DN: cn=Mark Corbin, o=USEPA, ou=EFED,
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Date: 2014.05.20 12:42:48 -04'00'

REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 $\mu\text{g}/\text{m}^3$ less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 $\mu\text{g}/\text{m}^3$ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean

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This is an addendum to the Environmental Fate and Effects Division's (EFED) ecological risk assessment for dicamba DGA salt (Clarity[®] formulation or M169I, EPA Reg No. 524-582) and its degradate, 3,6-dichlorosalicylic acid (DCSA), for the proposed new use on dicamba-tolerant soybean. It includes analysis of information that was not previously included in the original soybean new use risk assessment (USEPA, 2011, DP 378444). Since the original risk assessment was conducted, the registrant, Monsanto, has submitted:

- 1) field trial data that impacts EFED's previous analysis of spray drift,
- 2) data for incidents and inquiries from the use of dicamba DGA salt,

- 3) laboratory volatility data for dicamba DGA and DMA salt formulations, and
- 4) terrestrial plant reproductive effects data.

Additionally, this addendum includes analysis conducted by EFED regarding:

- 5) the implication of new mammalian chronic effects endpoints for parent dicamba and the metabolite DCSA from the Health Effects Division (HED; USEPA 2016, D378366+),
- 6) a revised T-REX run using refined estimates of foliar dissipation half-lives and variable application rates,
- 7) the potential for effects to beneficial terrestrial invertebrates,
- 8) effects posed by runoff, and
- 9) potential synergistic interactions with glyphosate.

1. Spray Drift and Buffers (Field Trial Data)

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that the distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate). However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-course droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect

distance for sensitive plants (the “no-effect” distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto’s statement that the field trial data are not suitable for use in EPA’s regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical

endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED's Process to Determine a "No Effect" Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered "controls," though there are considerable uncertainties to this approach. Specifically, no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these "controls" the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the "control" means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a "no effect" distance at each site was considered the first distance greater than the maximum distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the "no effect" distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.e./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 1. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than only 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Weight of Evidence Conclusions

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of this field trial data is not suitable for the purpose of establishing an appropriate buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.e./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTII 1004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate and with the described nozzles restricting the droplet spectra extra-coarse and ultra-coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

2. Incidents

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in

place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (e.g. burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (e.g. leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EIIIS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. The air temperature and humidity at the time of dicamba application were reported to be 82°F and 55%, respectively. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8

µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements, as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty whether this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing. Further discussion of volatility is provided in **Section 3** below.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where "dicamba type" damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto's submitted information on the 73 incidents from 2012-2014 (discussed previously in this section). With the current information available, and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri). The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made.

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that were not followed included tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants, and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize since the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more likely impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory data conditions. Additional discussion and characterization of volatility is provided in the next section.

3. Volatility

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, because these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 lb a.e./A application rate and 220 feet for the 1.0 lb a.e./A application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However, consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the previous section (MO Case File #81513M00701, EIIIS Incident report number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

4. Potential Effects on Terrestrial Plant Reproduction

EFED is aware of published literature associating dicamba applications with effects to soybean progeny. These studies indicate potential effects to the quantity and reproductive quality of future soybean generations following dicamba applications that would not be observed in the guideline vegetative vigor and seedling emergence studies EFED typically uses to assess risk to terrestrial plants. Therefore, these data raise a potential concern that has not been directly addressed in OPP assessments, should these effects occur at lower exposures than the effects observed in the guideline terrestrial plant studies. In meetings and email correspondence in January/February, 2015, OPP asked whether Monsanto was aware of this issue. Monsanto requested the references that OPP was aware of, so that they could independently review them.

Monsanto reviewed the open literature references provided by OPP and stated that none of the studies described effects on progeny at application rates lower than OPP's lowest available regulatory endpoint from the available vegetative vigor plant study (0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), therefore any mitigations (*i.e.* spray drift buffers) based on the plant height endpoint would be protective for effects to progeny.

The open literature studies examined seeds/pod, seed weight, seed quality, delayed maturation, pod malformation, reduced germination or progeny emergence, and malformed progeny. The vast majority of the studies did not investigate effects at rates as low as the NOAEC from the available vegetative vigor study. Monsanto's review of the available information indicated that the lowest effects endpoint reported from these studies was for delayed maturation of soybeans at rates as low as 0.56 g a.e./A from Kelley *et al.* (2005), which would still be almost 2 times less sensitive than the regulatory endpoint based on plant height that EFED has used in its risk assessments. Monsanto concluded that the open literature studies did not contain information that indicated that the in-field buffer based on plant height that is on the draft label would not also be protective of these reproductive effects.

EFED acknowledges Monsanto's submission of their analysis of the open literature data for effects to progeny, but to date has not independently reviewed each of these studies. However, for the following reason, EFED does not believe the information would change its risk assessments. The most sensitive endpoint reported in the open literature was a LOAEC of 0.56 g a.e./A for delayed maturation of soybeans (Kelley *et al.*, 2005; no NOAEC reported). As EFED's determination for risk to listed plant species is based on the most sensitive apical endpoint (*i.e.*, the NOAEC for soybean plant height from the available vegetative vigor study with dicamba DGA, 0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), less sensitive endpoints reported in the literature for effects to progeny would not impact EPA's risk assessments. EFED's policy regarding open literature is that typically if endpoints from the open literature are not more sensitive than guideline endpoints, then further analysis is not required (USEPA, 2011b)

5. Revised Terrestrial Vertebrate Endpoints

Parent Dicamba

The risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016, D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. The revised T-REX run presented in **Section 6** of this addendum reflects the adjusted chronic endpoint for parent dicamba.

Metabolite DCSA

Following preliminary review of a rat 2-generation study with DCSA (MRID 47899517), the risk assessment for the proposed new use on soybeans (USEPA, 2011 D378444) used a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016) was completed to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016) determined BMD₅ (estimated benchmark dose [BMD] to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised T-REX analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

6. Revised T-REX Analysis for Parent Dicamba and Quantitative Assessment of DCSA Exposure and Risk

Dicamba-specific Half-Life

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. However, EFED has refined this analysis by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application); a chemical-specific foliar dissipation half-life value for parent dicamba

(described below); and the new chronic mammalian endpoint for parent dicamba (described previously in **Section 5**).

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 2**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 2. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Parent Dicamba T-REX Analysis

Modeled maximum residue values (EECs) determined using this refined approach were slightly higher (~15%) than those determined in the original dicamba-tolerant soybean Section 3 assessment, but would not have impacted the screening-level risk conclusions for any assessed taxa. The previous risk assessment (2011) concluded that there was potential for direct adverse effects to mammals from chronic exposures of dicamba (max chronic RQ was 2.31 for small mammals consuming short grass). Following the refinements presented in this section (3 applications of dicamba to include the two post-emergent applications at the 0.5 lb a.e./A rate, foliar dissipation half-life decreased from 35 days to 8.4 days, and an increase in the mammalian chronic endpoint from 45 mg/kg-bw to 136 mg/kg-bw), there are no longer any exceedances for any size class of mammal consuming any dietary item (max RQ = 0.84, see **Appendix 1** for full T-REX input and output)

DCSA Metabolite Exposure Analysis

Since the chronic toxicity endpoints are more sensitive for DCSA than dicamba and DCSA residues were higher than dicamba residues within dicamba-tolerant soybean plant tissues (see below), EFED separately assessed the chronic exposure to DCSA residues for birds and mammals.

The available data indicate that DCSA has similar acute toxicity as parent dicamba, but is substantially more toxic on a chronic basis to mammals. In conventional soybean plants, DCSA residues following dicamba applications prior to planting were less than 2% of total dicamba residues in forage, hay and seed (MRIDs 43814101 and 44089307; max of 0.130 ppm DCSA, see **Appendix 2**) and would not be above toxicity thresholds for any taxa. However, in dicamba-tolerant soybean plants, dicamba is converted to DCSA and its glycosidic conjugates following demethylation of the aromatic methoxy moiety of dicamba (USEPA, 2013. HED residue chemistry summary) and in comparison to dicamba use on conventional soybeans, the maximum residues of DCSA in dicamba-tolerant soybean field trials following one 1-lb/A pre-emergent application and two 0.5-lb/A post-emergent applications were a substantially higher proportion of dicamba-related residues in forage, hay and seed (**Appendix 2** and MRID 47899524; 76%--88% of total dicamba-related residues). The empirical data from MRID 47899524 found means and maximums, respectively, of DCSA concentrations of 17.0 and 51.3 ppm, in forage 7-10 days following the last application, 32.2 and 61.1 ppm in hay 13-15 days following the last application and 0.059 and 0.440 ppm in seeds 73-98 days after the last application. EFED used the maximum measured values from the empirical data on forage, hay and seeds to assess risk to terrestrial vertebrates. There is some uncertainty in this approach as the maximum DCSA residues appear to be slightly increasing (16%) between forage at 7-10 days and hay at 13-15 days, however this could be due to the difference between fresher forage and drier hay, where DCSA has become more concentrated compared to the overall plant biomass, rather than due to additional conversion of dicamba residues to DCSA. Additionally, the amount of additional dicamba available to potentially convert to DCSA appears limited after this point as the maximum residues of dicamba were only 2.62 and 1.16 ppm in forage and hay, respectively.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-soybean and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization. This is because the conversion of dicamba to DCSA in plants is only expected to occur in crops modified to be tolerant to dicamba.

DCSA Effects Assessment

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds, resulting in a chronic avian endpoint of 40.9 mg/kg-bw. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who would not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into the egg during egg development).

Using the empirical dataset for DCSA residues in DT-soybean crops (as described above), the maximum residues in soybean forage and hay tissue were 61.1 ppm and in seeds were 0.440 ppm. Residues in arthropods (as a dietary item for birds and mammals consuming insects that

have consumed soybean tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications and therefore were considered to contain 42.5 ppm. This is likely conservative, given that the residues from the nomogram are for external residues in food items following a spray application while the actual exposures would be internal residue concentrations in the plant. A screening assessment using this empirical data for the exposure values results in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay tissue or consuming insects that had consumed soybean tissues with DCSA residues (RQs range from **1.1—3.3**, **Table 3**), for small birds consuming forage and hay tissue or insects that had fed on DT-soybean tissues, (RQs range from **1.2—1.7**, **Table 4**) and medium birds feeding on forage/hay tissue (marginal exceedance of **1.0**) but no exceedances occurred for any size mammalian or avian granivore consuming soybean grain (max granivore RQ of < 0.01).

Table 3. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-soybean tissues containing DCSA residues (maximum 61.1 mg/kg in forage/hay, 0.44 mg/kg in seeds) or consuming arthropods that had fed on DT-soybean tissues (assumed to contain 42.5 mg/kg DCSA). Bold RQ values exceed the LOC.

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Forage/Hay	0.0143	58.25	6.2	3.3
	Seed	0.00318	0.09	6.2	<0.01
	Arthropod	0.0143	40.52	6.2	2.3
Medium (35g)	Forage/Hay	0.0231	40.33	14.2	2.8
	Seed	0.00513	0.06	14.2	<0.01
	Arthropod	0.0231	28.05	14.2	2.0
Large (1000g)	Forage/Hay	0.153	9.35	17.6	1.5
	Seed	0.0340	0.01	17.6	<0.01
	Arthropod	0.153	6.50	17.6	1.1

Table 4. Dose-based exposure and risk quotients for birds consuming DT-soybean tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA for birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Forage/Hay	0.0228	69.65	40.9	1.7
	Seed	0.0051	0.11	40.9	<0.01
	Arthropod	0.0228	48.45	40.9	1.2
Medium (100g)	Forage/Hay	0.0649	39.65	40.9	1.0
	Seed	0.0144	0.06	40.9	<0.01
	Arthropod	0.0649	27.58	40.9	0.7
Large (1000g)	Forage/Hay	0.291	17.78	40.9	0.4
	Seed	0.065	0.03	40.9	<0.01
	Arthropod	0.291	12.37	40.9	0.3

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-soybean tissues (forage from days 7-10, hay from days 13-15 and seeds from

days 73-98) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-soybean plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure.

As noted above, EFED calculated these RQs based on the female lactation dose NOAEL endpoint of 8 mg/kg/d from the DCSA 2-generation study where reductions of up to 9% pup body weight were observed 2-3 weeks post birth at the next highest dose (78 mg/kg/d). If the BMDL₅ (the lower 95% confidence level on the estimated benchmark dose to result in a 5% body weight change in pups from background levels) of 34.9 mg/kg/d calculated by HED (EPA, 2016) for DCSA was used in place of the NOAEL, then the maximum residues from the empirical data in soybean hay would be below the threshold dose for all size classes of mammals feeding on soybean plant tissue or soybean-consuming arthropods (RQs would range from 0.35—0.76 for mammals feeding on tolerant soybean tissues and 0.24—0.53 for mammals feeding on arthropods having consumed soybean tissues).

7. Terrestrial Invertebrates Risk Characterization

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum¹ establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This addendum document explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial

¹ <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact $LD_{50} > 91 \mu\text{g a.e./bee}$ (MRID 00036935). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LD_{50} (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate ($1.0 \text{ lbs a.e./A} \times 2.7 \mu\text{g a.e./bee}$ (upper bound for contact exposures from a direct spray of 1 lb a.e./A , based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 ($2.7/91$) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral $LC_{50} > 100 \mu\text{g a.e./bee}$). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC_{50} (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of $32.12 \mu\text{g/bee/bee/day}$ ($1.0 \text{ lb a.e./A} \times 110 \mu\text{g a.e./g}$ {upper-bound residue for tall grass from T-REX} $\times 0.292 \text{ g/day}$ {pollen consumption rate}), the resultant RQ would be 0.32 ($32.12/100$) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may

² The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured. Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the soybean risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ³	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁴

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

³ Test material was dicamba BAPMA salt

⁴ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated contact-based bee chronic NOAEC of 38 µg a.e./bee. The acute dietary estimated exposure level for adult honeybees is 32.12 µg/bee/day for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 µg a.e./bee. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (*e.g.*, an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary

exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate developmental life stages and survival in organisms following prolonged exposure); and
2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the soybean risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning in summer, 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-soybean plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

8. *Runoff*

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). According to the original ecological risk assessment (USEPA, 2011a), dicamba is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 3** for calculations). Using these assumptions in TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 3**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

9. *Herbicide Interactions (Synergism)*

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba

and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent application (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans

Chemical Identity and Application Information

Chemical Name: Dicamba

Seed Treatment? (Check if yes) ☐

Use:

Product name and form:

% A.I. (leading zero must be entered for formulations <1% a.i.):

Half-life (days):

Are you assessing applications with variable rates or intervals? ☒

Seeding Rate (lbs/acre) 166.7

Reset Model

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

The value in G6 must be zero

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian

Endpoint	Toxicity value	Indicate test species below
LD50 (mg/kg-bw)	188.00	<input type="text" value="Subacute oral"/>
LC50 (mg/kg-diet)	10000.00	<input type="text" value="Subacute oral"/>
NOAEL (mg/kg-bw)		<input type="text" value="Subacute oral"/>
NOAEC (mg/kg-diet)	695.00	<input type="text" value="Mixed oral"/>

Enter the Mineau et al. Scaling Factor 1.15

Mammalian

Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			Reference (MRID)
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		

Optional Test Organism in body weight (g)

Optional Test Species Name	Toxicity Value Reference (MRID)

Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose

2720

mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.87	4.16	0.03
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.39	2.37	0.01
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.12	1.06	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients

NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.0163	3.4819	0.0006
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.0139	2.4065	0.0005
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.0075	0.5579	0.0003

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.33	3.48	0.01
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.28	2.41	0.01
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.15	0.56	0.01

Appendix 2. Dicamba Crop Field Trial Residue Data Which Include the Determination of the DCSA Metabolite.

Table 1. Summary of Residues from Conventional Asparagus Crop Field Trials with DCSA as a Dicamba Residue of Concern.¹

Formulation ²	Total Application Rate (lb ae/A)	PHI (days)	N ³	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁵	HAFT ⁵	Median ⁵	Mean ⁵	SD ⁵
4 lb ae/gal DGA SL, 4 lb ae/gal DGA SL, and 2 lb ae/gal Na SL	Single post-emergence broadcast application of 0.5 lb ae/A	1	24	Parent	0.266	3.274	0.304	3.144	0.604	0.967	0.852
				DCSA ⁴	<0.01	0.071	<0.01	<0.040	0.011	0.014	0.0069
				Total	0.271	3.192	0.314	3.166	0.622	0.981	0.854

¹ Asparagus data are taken directly from MRID Nos. 43245206 and 43425803 (D204488, D204809, and D209229, L. Cheng, 07/14/1997) used for tolerance re-assessment in the 2005 RED.

² Test applications included the dimethylamine (DMA), diglycolamine (DGA), and sodium (Na⁺) salt formulations.

³ number of samples.

⁴ DCSA is the 3,6-dichloro-2-hydroxybenzoic acid metabolite.

⁵ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 2. Summary of Residues from Conventional Soybean Crop Field Trials (Seed) with DCSA as a Dicamba Residue of Concern.^{1,2}

Formulation ³	Total Application Rate (lb ae/A)	PHI (days)	N ⁴	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁶	HAFT ⁶	Median ⁶	Mean ⁶	SD ⁶
4 lb ae/gal DMA SL	Single 0.5 lb ae pre-plant treatment followed by a single post-emergence application of 2.0 lb ae/A	7	24	Parent	0.027	8.10	0.038	7.40	0.72	1.022	1.703
				DCSA ⁵	<0.01	0.130	<0.01	<0.048	.014	0.02	0.015
				5-OH dicamba	<0.01	0.360	<0.01	0.26	0.01	0.043	0.071
				Total	0.047	8.14	0.084	7.44	0.768	1.085	1.713

¹ Soybean grain data are for the 1X rate which used a 0.5 lb ae/A treatment made at 14-days pre-planting followed by a 2.0 lb ae/A treatment made at 7-days prior to harvest taken directly from MRID Nos. 43814101 (D223283, S. Knizner, 07/29/1996) and 44089307 (D228703, S. Chun, 07/16/1998) used for tolerance reassessment in the 2005 RED.

² The registrant was not supporting tolerances for soybean forage and hay at this time in lieu of a feeding restriction placed on the label. However, data were included for these commodities in the study submissions acquired using a single 0.5 lb ae/A treatment made at 14-days pre-planting (0.25x the maximum rate). Total residues of dicamba (parent, DCSA, and 5-OH dicamba) were <0.03 - <0.097 ppm in soybean forage and <0.03 - <0.04 ppm in soybean hay.

³ Test applications included the dimethylamine (DMA) salt formulation.

⁴ number of samples.

⁵ DCSA is the 3,6-dichloro-5-hydroxybenzoic acid metabolite.

⁶ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 3. Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

¹ Except for sample min/max, values reflect per trial averages; n = no. of field trials. For calculation of median, mean, and standard deviation, the LOQ (0.02 ppm each analyte in undelinted cotton seed and 0.04 ppm for each analyte in cotton gin byproducts) was used for any results reported as <LOQ in Table C.3. Combined residues of dicamba, 5-OH dicamba, DCSA, and DCSA are expressed in parent equivalents. Individual analyte results are reported as per se. N/A = Not applicable.

² LAFT = lowest-average-field-trial; HAFT = highest-average-field-trial.

Table 4. Summary of Residues from Dicamba-Tolerant Soybean Crop Field Trials with DCSA as a Dicamba Residue of Concern.									
Commodity	Total Applic. Rate lb a.e./A (kg a.e./ha)	PHI (days)	Residue Levels ^{a, b} (ppm)						
			N	Min.	Max.	HAFT	Median (STMdR)	Mean (STMR)	Std. Dev.
DCGA ^c									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	0.356	5.90	5.27	1.93	2.02	1.02
Hay		13-15	44	0.167	7.26	7.19	2.00	2.66	1.91
Seed		73-98	44	<0.011	0.135	0.131	0.017	0.032	0.029
DCSA									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	8.92	51.3	50.4	15.0	17.0	8.00
Hay		13-15	44	12.2	61.1	60.7	31.9	32.2	11.2
Seed		73-98	44	0.010	0.440	0.439	0.033	0.059	0.089
Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	2.62	2.47	0.068	0.374	0.603
Hay		13-15	44	<LOQ	1.16	1.01	0.051	0.130	0.216
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
5-OH Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	0.009	0.009	0.005	0.006	<LOQ
Hay		13-15	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

^aConcentrations of the individual analytes are reported as dicamba equivalents

^bValues < LOQ are assumed to be at the LOQ.

^c DCGA residues were quantitated by a non-validated method

Appendix 3: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in **Table 1** for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure 1**. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in **Tables 2** and **3**.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%). In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40	105

°Lat	
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

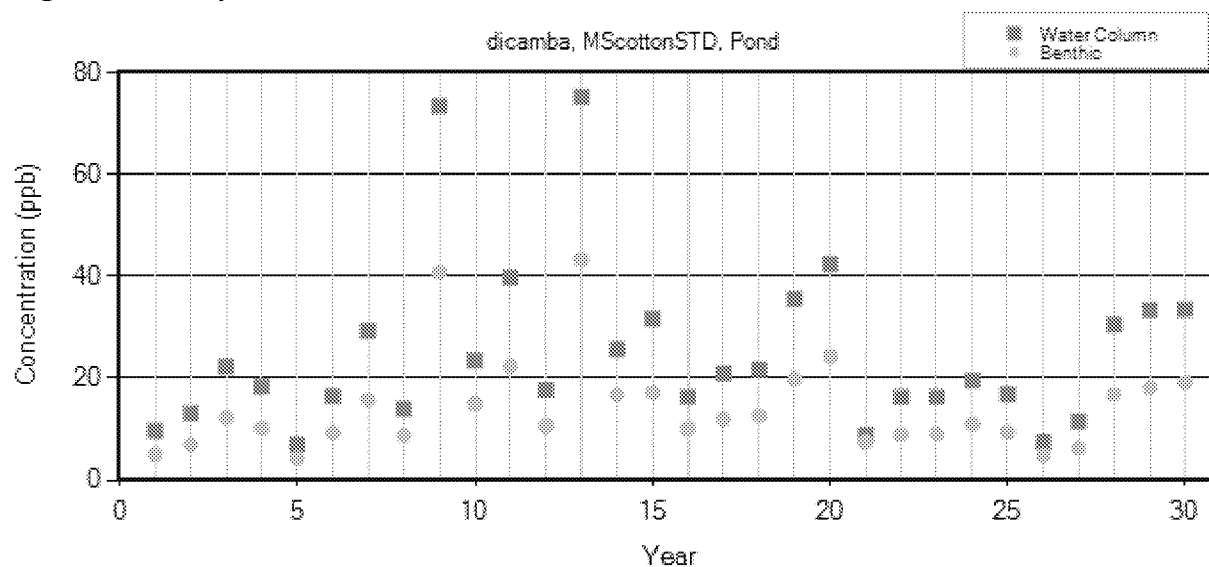


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (102,790 \text{ L water/ Acre-in}) * (1 \text{ inch}) * (1 \text{ lb/ } 453,592 \text{ mg})$
which reduces to:

Equation 2.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (0.226613)$

$EEC \text{ lb ai/A} = 0.061 \text{ mg/L} * 0.226613 = 0.0138$

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be $EEC \text{ lb ae/A} = 0.005 \text{ mg/L} * 0.226613 = 0.0011$. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e./A application rate and 0.06% loss through runoff and erosion.

Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (GrIM) 3-8-11
Michael Wagman 3/8/11

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatotoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

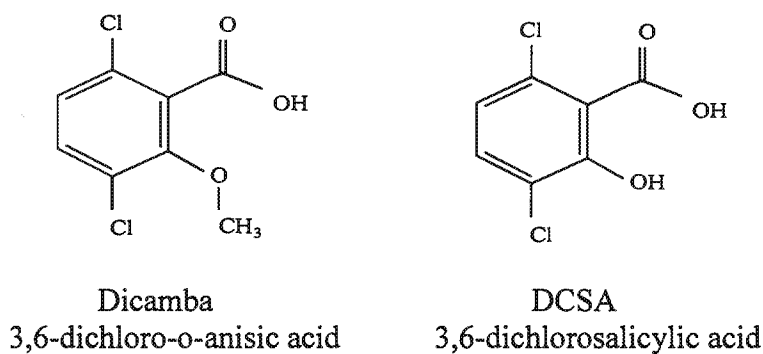
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		

¹- M1691 Herbicide

²- Registered uses

³- "Acid equivalent"

⁴- Calculated by dividing the max application rate by the max individual application rate.

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

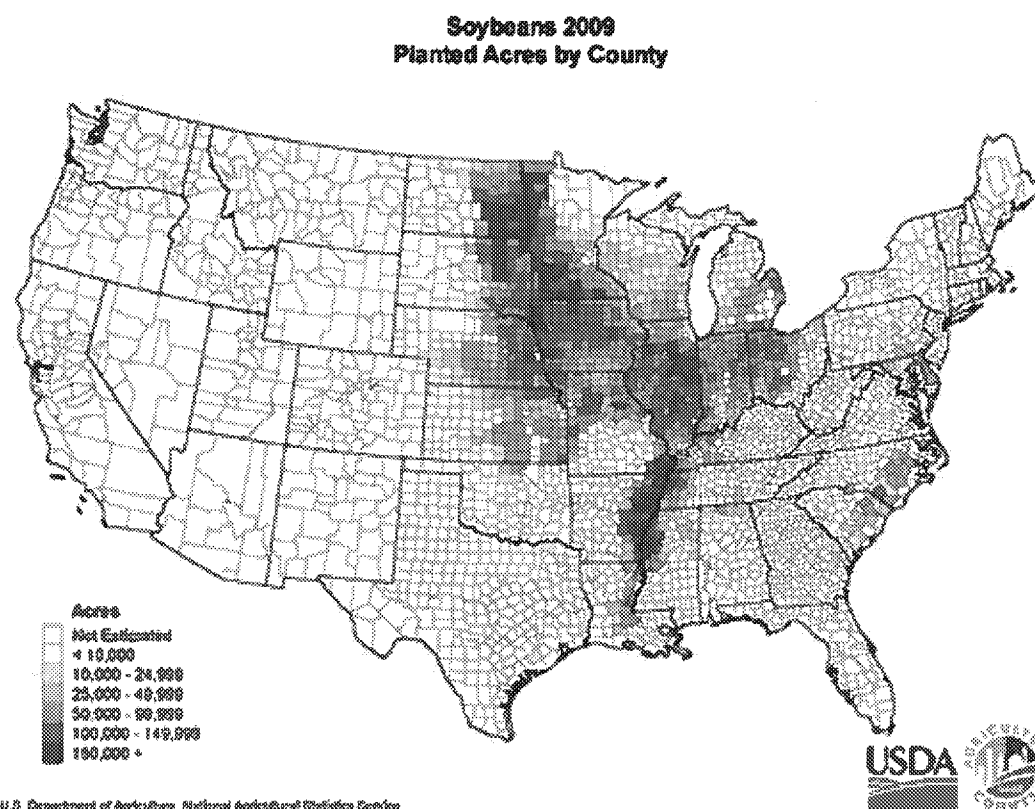


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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APPENDIX I

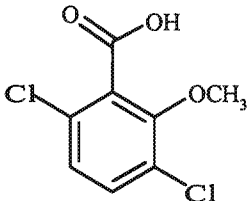
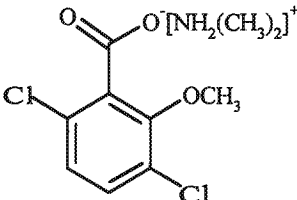
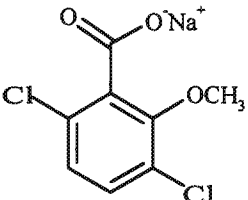
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

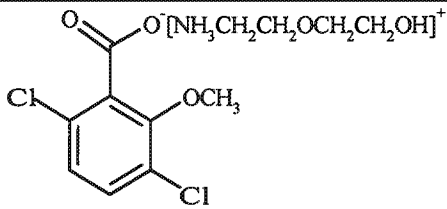
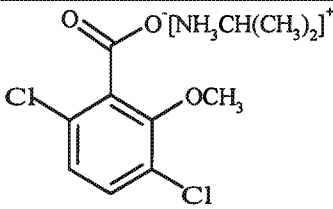
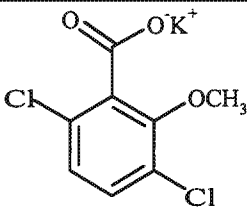
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
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Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSSoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Message

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 10/18/2016 5:59:46 PM
To: Adeeb, Shanta [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd827c964d6042eb87b3d98b2539bfb9-Adeeb, Shan]
Subject: Real Dicamba Final Decision Draft.
Attachments: Dicamba Final Decision - Draft.rtf

*Grant Rowland
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Codes: 029801, 029802, 029803, 029806, 128931, 129043, 128944

DP Barcode: 426710

Date: June 13, 2016

MEMORANDUM

SUBJECT: Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba

FROM: Michael Wagman, Biologist
William P. Eckel, Senior Science Advisor
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

MICHAEL
WAGMAN

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DN: c=US, o=U.S. Government, ou=EPA,
ou=Staff, cn=MICHAEL WAGMAN,
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Date: 2016.06.13 16:00:57 -0400

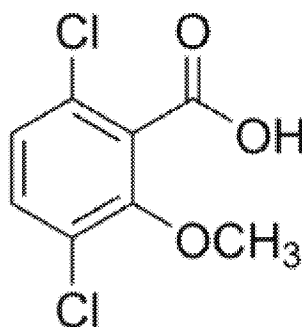
THROUGH: Mark Corbin, Branch Chief
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Melanie Biscoe, Team Leader
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Pesticide Re-Evaluation Division (7508P)



Office of Chemical Safety
and Pollution Prevention

**Problem Formulation for the Environmental Fate, Ecological Risk,
and Drinking Water Exposure Assessments in Support of the
Registration Review of Dicamba**



3,6-Dichloro-*o*-anisic acid, salts and esters

CAS Registry Number: 1918-00-9

PC Codes: 029801, 029802, 029803, 029806, 128931, 128944, 129043

Prepared by:

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June 13, 2016

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1. Executive summary

The Environmental Fate and Effects Division (EFED) has completed the preliminary problem formulation for the ecological risk, environmental fate, and drinking water assessments to be conducted as part of the registration review of dicamba. This action includes dimethylamine salt (DMA-salt, PC code 029802), diethanolamine salt (DEA-salt, PC code 029803), sodium salt (Na-salt, PC code 029806), diglycoamine salt (DGA-salt, PC code 128931), potassium salt (K-salt, PC code 129043), isopropylamine salt (IPA-salt, PC code 128944) and dicamba acid (dicamba, PC code 029801). Dicamba monoethanolamine salt, triethanolamine salt, methoxybenzoic acid, and aluminum salt were not included in this action as there are no current product registrations for these active ingredients. The problem formulation describes the methods planned to be used during the completion of drinking water and ecological risk assessments in support of registration review and provides an overview of the environmental fate, ecological effects, and potential risks associated with the use of dicamba as well as uncertainties unique to the risk assessment of dicamba. This document also identifies additional studies that would be beneficial to the conduct of an ecological risk assessment. Major findings include:

Data needs for dicamba ecological effects are:

Data on parent dicamba (test guidelines and PC codes in parentheses):

- *Oyster Acute Toxicity Test (shell deposition, OCSPP guideline 850.1025) using TGAI, dicamba acid (029801)*
- *Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)*
- *Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)*
- *Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available*
- *Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species*
- *Seedling Emergence and Seedling Growth (850.4100) using TEP, dicamba acid (029801) on standard suite of 10 terrestrial plant species*
- *Vegetative Vigor (850.4150) using TEP, dicamba acid (029801), DMA-salt (029802), DEA-salt (029803), Na-salt (029806), K-salt (129043) and IPA salt (128944) with 7 terrestrial plant species (onion + 6 dicot species). For DGA-salt (128931), 1 species (lettuce) is required.*
- *Aquatic Plant Toxicity Test Using Lemna spp. (850.4400) using TGAI, dicamba acid (029801)*
- *Tier 1 Adult Honey Bee Acute Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Larval Honey Bee Acute Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*
- *Tier 1 Larval Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)*

- *Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.*
- *Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies*

In addition, the following effects data is needed for dicamba's major degradate, DCSA:

- *Fish Early-Life Stage Toxicity Test (850.1400) using dicamba's metabolite, DCSA and the same species as used in the test with TGA dicamba.*
- *Daphnid Chronic Toxicity Test (850.1300) using dicamba's metabolite, DCSA.*
- *Avian Reproduction Test (850.2300) using dicamba's metabolite, DCSA and the mallard duck*

Data needs for environmental fate and exposure assessment are:

Data on parent dicamba:

- *Environmental Chemistry Methods and independent laboratory validations for dicamba and DCSA in Soil and Water (850.6100)*
- *Laboratory Volatility (835.1410) for each registered salt and ester formulation intended for use on GMO crops*
- *Field Volatility (835.8100) for each registered salt and ester formulation intended for use on GMO crops.*
- *Spray Droplet Size Spectrum (840.1100) and Spray Drift Field Deposition (835.1200) for each formulation intended for use on GMO crops.*
- *For parent dicamba, additional data on aerobic soil metabolism (835.4100) with US soils.*
- *For parent dicamba, additional data on aerobic aquatic metabolism (835.4300, currently only one study submitted).*

In addition, the following fate data is needed for dicamba's major degradate, DCSA:

- *For the major degradate, dichlorosalicylic acid (DCSA), additional data on aerobic soil metabolism (835.4100).*
- *For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).*

Major uncertainties:

Spray drift was the major route of exposure considered in the risk assessments for dicamba use on GMO cotton and soybeans. Any new formulations for which an Endangered Species Act effect determination must be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300).

Post-application volatilization of dicamba as the acid was a major uncertainty in risk assessments for use on GMO cotton and soybeans. Several formulations of dicamba are intended to reduce volatilization of dicamba in the first few days after application, but the ability of these formulations to delay the formation of the volatile dicamba acid, under a range of environmental conditions, is not well understood. It is also not understood whether off-site movement due to

volatilization is as great as from spray drift at the time of application. Field volatility tests (835.8100) will reduce this uncertainty.

Some GMO crops detoxify dicamba by metabolizing it to 3,6-dichlorosalicylic acid (3,6-DCSA), which is more toxic than parent dicamba to some taxa, including mammals. DCSA is a major degradate under anaerobic aquatic metabolism conditions. Additional chronic toxicity tests using this degradate are required for daphnids, fish and birds.

2. Introduction

Dicamba is a systemic herbicide in the benzoic acid chemical class similar in structure and mode of action to phenoxy herbicides. Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

The use information presented in this problem formulation was obtained from the tables in the EFED Label Data Report dated 6/22/2015, from BEAD's Chemical Profile for Registration Review (USEPA, 2015), and from various evaluated labels. Across the acid and six salts with active registrations, there are a total of 479 end use registrations

Recent labels (*e.g.* the M1691 label, EPA Reg. No. 524-582, containing dicamba DGA salt) contain environmental hazard information regarding the known potential for dicamba to leach into groundwater under certain conditions, such as where soils are permeable or the water table is shallow, but this language does not appear on older labels.

The following labeling statement appears on all dicamba labels to avoid contamination of aquatic environments and drinking water from use on agricultural products.

ENVIRONMENTAL HAZARD STATEMENTS

Keep out of lakes, streams or ponds. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high watermark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on label.

3. Use Characterization

Dicamba is a systemic herbicide in the benzoic acid chemical class similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves. Dicamba was first registered in the United

States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures.

It is registered for use on agricultural crop soils for the following: asparagus, barley, corn, cotton, fallow, grasses grown for seed/forage/fodder/hay, oats, proso/millet, sorghum, soybeans, sugarcane, triticale, wheat, pasture/rangeland and forestry. It is also registered for use on non-agricultural use sites including farm and domestic premises, conservation reserve program land, commercial/industrial lawns, recreational/residential lawns, golf course turf, rights-of-way, fencerows and hedgerows, ornamental herbaceous plants, ornamental woody shrubs and vines, ornamental lawns and turf, ornamental sod (turf), paved areas and paths/patios. On soybean and cotton, it is registered for both pre-emergent use and, on dicamba-tolerant soy and cotton plants only, for post-emergent use as well.

Dicamba is formulated as emulsifiable, soluble concentrate, granular, wetted powder, FIC, and as a solution-ready-to-use. Dicamba can be applied by broadcast spray (aerial and ground), spot treatment, banded, wipe on/wipe off treatment, cut-stem treatments and as a basal bark treatment. The Screening Level Usage Analysis (SLUA) produced by BEAD (**Table 1**, compiled on June 22, 2015) indicates that the greatest uses of dicamba are on corn (1.5 million pounds per year, used on an average of 10% of the crop), pasture and fallow (1.1 million pounds per year) and wheat (500,000 pounds per year used on an average of 10% of the crop).

Table 1. Screening Level Estimates of Agricultural Uses of Dicamba (PC codes: 029801, 029802, 029803, 029806, 128931, 129043, and 128944). Based on reporting years from 2004—2013.

	Crop	Annual Average	Percent Crop Treated	
		Lbs. A.I.	Average	Maximum
1	Alfalfa+	2,000	<1	<2.5
2	Asparagus	<500	5	10
3	Barley	20,000	5	10
4	Canola+	2,000	<2.5	10
5	Corn	1,500,000	10	15
6	Cotton	200,000	5	15
7	Dry Beans/Peas+	3,000	<2.5	<2.5
8	Fallow	500,000	15	35
9	Oats	6,000	<2.5	<2.5
10	Pasture	600,000	<2.5	5
11	Peanuts+	1,000	<1	<2.5
12	Pecans+	1,000	<2.5	<2.5
13	Rice	3,000	<1	<2.5
14	Sorghum	200,000	15	25
15	Soybeans	100,000	<2.5	<2.5
16	Squash+	<500	<2.5	<2.5
17	Sugarcane	40,000	20	25

18	Sunflowers+	9,000	5	10
19	Sweet Corn	<500	<1	<2.5
20	Wheat	500,000	10	25

A number of labels for use in agricultural fallow/conservation reserve land, barley, cotton, forestry, pastures, rangeland, ornamental turf and soybeans do not specify the maximum number of applications per year. Without clarification of the labels or details on usage in these use sites, conservative assumptions will be made.

The tables in **Appendix A** summarize use patterns for dicamba acid (PC code 029801; MW: 221.0 g/mol), the DMA-salt of dicamba (PC code 029802; MW: 226.1 g/mol), the DEA-salt of dicamba (PC code 029803; MW: 326.18), the Na-salt of dicamba (PC code 029806; MW 243.0 g/mol), the DGA-salt of dicamba (PC code 128931; MW: 326.18), the IPA-salt of dicamba (PC code 128944, MW: 280.04 and the K-salt of dicamba (PC code 129043; MW: 259.1 g/mol). Though these are distinct chemical moieties, they will be assessed together using the acid equivalence (a.e.) method. That is, only the dicamba acid component will be assessed and the application rates of the DMA-salt, the DEA-salt, the Na-salt, the DGA-salt, the IPA-salt and the K-salt will be adjusted to account for only dicamba acid.

4. Conclusions from Previous Risk Assessments

4.1. Ecological Risk Assessment

The most recent ecological risk assessments conducted on dicamba or its associated salts were the 2016 risk assessment for the use of dicamba DGA salt on dicamba-tolerant (DT-) cotton (USEPA, 2016a; D404823), an addendum to the use of dicamba DGA salt on dicamba-tolerant (DT-) soybean (USEPA, 2016b; D426789) and refined endangered species assessments for 34 states (USEPA, 2016c-e; D416416+, D422305, D425049) for the use of DGA salt on dicamba-tolerant soybeans and cotton. The Tier I risk assessment on DT-cotton and the addendum on DT-soybean identified that potential direct risk concerns could not be excluded for mammals (chronic, due to residues of dicamba's metabolite, DCSA in DT-soybean), birds (acute for both uses from parent dicamba, chronic in soybean only, due to DCSA residues in DT-soybeans) and terrestrial plants (both uses, from parent dicamba). Residues of DCSA in DT-soybean plant tissues were found to be higher than residues of parent dicamba and persisted longer. These documents also addressed concerns regarding the potential for dicamba to move off-site through spray drift, volatility and run-off and specified an in-field buffer (designed to keep dicamba residue concentrations above which could cause adverse effects restricted to the field) specific to the tested DGA-salt formulation (M1691, EPA Reg No. 524-582) with specific nozzle requirements intended to restrict the droplet spectra to ultra-coarse and extremely coarse sized droplets.

EFED completed the reregistration chapter for dicamba/dicamba salts in 2005 (USEPA, 2005). The RED assessment determined that bridging data indicate that dicamba salts will rapidly convert to the free acid of dicamba and that the submitted ecological effects data generally

indicate similar toxicity of the acid and salts (based on acid equivalents). Therefore, EFED concluded that environmental fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. However, the EFED RED chapter also identified data gaps for seedling emergence and vegetative vigor studies for dicamba acid and all salts, using typical end-use products (TEP) and requested these studies for the 5 most sensitive species in available plant tests with technical grade active ingredient (TGAI) dicamba acid (soybean, onion, turnip, tomato and lettuce). Seedling emergence and vegetative vigor data were subsequently submitted and determined to be acceptable for dicamba DGA salt, but not for any of the other salts or for a dicamba acid TEP.

4.2. *Drinking Water Exposure Assessments*

A comprehensive drinking water assessment was performed for dicamba at the time of the RED in 2005. Later assessments for new uses on sweet corn and sugarcane were done in 2005 and 2007.

A new drinking water assessment will be performed for Registration Review, because both the models and guidance for such assessments has changed considerably since 2005. This will include a new ground water assessment with PRZM-GW, as part of the Pesticides Water Calculator (PWC).

The new assessment will address the degradate DCSA (dichlorosalicylic acid), which is formed in greater amounts by crops engineered to be resistant to dicamba.

4.3. *Clean Water Act Programs*

Dicamba is not identified as a cause of impairment for any water bodies listed as impaired under section 303(d) of the Clean Water Act. No Total Maximum Daily Load (TMDL) criteria have been developed for dicamba. Aquatic benchmarks have been established for dicamba acid and its dimethylamine (DMA) and sodium salts and are available at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-pesticide-registration>. Any data submitted or otherwise located as part of the registration review process may be used to update aquatic life benchmarks if applicable.

5. Environmental Fate and Transport

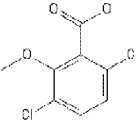
Dicamba as the acid is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs ($pK_a = 1.9$). Dicamba is not stable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization. It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target

plant injury.¹ Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major routes of exposure to non-target organisms is likely spray drift, runoff and volatilization. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in **Table 2**. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the cited documents (USEPA, 2005 and USEPA, 2011). Physical properties of dicamba acid are given in **Table 3**. Aquatic modeling input parameters are given for dicamba acid in **Table 4** and for 3,6-DCSA in **Table 5**.

Table 2. Chemical Structures Relevant to this Assessment

<p>Dicamba acid <chem>COc1c(Cl)ccc(Cl)c1C(=O)O</chem></p>	
--	--

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

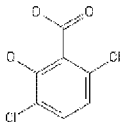
3,6-dichlorosalicylic acid (DCSA)	
<chem>C1(=C(C(=CC=C1Cl)Cl)O)C(=O)O</chem>	

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))
Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZ Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)

Vapor Pressure	3.41 E-05 torr (25°C) SANDOZ Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

TABLE 4. Fate Data for Dicamba.

Model Input Variable	Input Value	Source and Comments
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. Fate Data for Dicamba's Metabolite, DCSA.

Model Input Variable	Input Value	Source and Comments
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

6. Receptors

Tables 6 through 16 provide a summary of the aquatic and terrestrial taxonomic groups, and the most sensitive surrogate species tested to characterize the potential acute and chronic ecological effects of dicamba and its associated salts. In addition, the tables provide a preliminary overview of the potential acute toxicity of dicamba and its associated salts by providing the acute toxicity classifications. In the following tables, the toxicity endpoint values for all the salts have been converted to dicamba acid equivalents to facilitate comparison between the different forms and these values will be used in the risk assessment.

6.1. *Effects to Aquatic Organisms*

Tables 6-11 show the most sensitive available aquatic toxicological data for dicamba acid and its associated salts adjusted to acid equivalents. No aquatic ecotoxicity data are available for the diethanolamine salt (PC code 029803). Based on the available ecotoxicity information, dicamba and its associated salts are practically non-toxic to slightly toxic on an acute basis to estuarine/marine and freshwater fish (dicamba acid appearing to be the most toxic) and generally practically non-toxic to freshwater and estuarine/marine invertebrates, except for one TEP study with dicamba Na-salt (MRID 00085935) that indicated this formulation was moderately toxic on an acute basis to freshwater invertebrates (48-hr EC₅₀ of 9.2 mg a.e./L. Given that dicamba salts should disassociate to the acid rapidly in water, and the evident lack of toxicity observed in all the other available freshwater invertebrate studies, it is likely that the observed toxicity in this study is due to effects from the formulation, rather than toxicity specific to the sodium salt. However, this value could potentially be used qualitatively as a conservative estimate of toxicity across dicamba acid and other salts in the risk assessment. No acute data are available for assessing the toxicity of dicamba or its associated salts to estuarine/marine mollusks and no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this uncertainty. For aquatic plants, dicamba appears to be more toxic to non-vascular plants than to vascular plants, however there is some uncertainty to this as the available study with duckweed (MRID 42774111) was initiated with highly acidic

conditions (pH 4.9-5.0) which may have impacted control performance and masked any treatment-related effects. Therefore, a new study with duckweed is requested at this time.

No acute or chronic aquatic toxicological data is available for dicamba's metabolite, DCSA, though the EU's footprint database² reports similar acute toxicity of DCSA to parent dicamba and significantly lower toxicity of DCSA to aquatic plants. Ecosar v1.1, a model predicting toxicity based on a chemical's molecular structure predicts DCSA to be both at least 30 times more toxic on a chronic basis than parent dicamba to fish and several orders of magnitude more toxic than parent dicamba to freshwater invertebrates using the neutral organic chemical class for comparison. The uncertainty in using the neutral organic Ecosar class for the acids, dicamba and DCSA, is acknowledged. Additionally, as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA. Given the known increased chronic toxicity of the degradate to mammals compared to parent dicamba and the model's predicted chronic toxicity differential to fish and invertebrates based on the chemical structures of the parent and degradate, the lack of chronic data for fish and invertebrates potentially exposed to the major metabolite DCSA is considered a major data gap.

Table 6. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for Dicamba acid (PC Code 029801)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source/Classification
Freshwater fish ¹	Acute	TGAI 88%	Rainbow trout (<i>Oncorhynchus mykiss</i>)	96-hr LC ₅₀ = 28 mg a.e./L Nominal	Slightly toxic	MRID 40098001/ Supplemental — Quantitative
	Chronic (Early Life-Stage)	--	No Data	N/A	N/A	N/A
Freshwater invertebrates	Acute	TGAI 88%	Water Flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ > 100 mg a.e./L Nominal	Practically non-toxic	MRID 40098001/ Supplemental — Quantitative
	Chronic	--	No Data	No Data	N/A	N/A
Estuarine/marine fish	Acute	TGAI 86.8%	Sheepshead minnow (<i>Cyprinodon variegates</i>)	96-hr LC ₅₀ > 180 mg a.e./L Nominal	Practically non-toxic	MRID 00025390/ Acceptable
	Chronic	--	No Data	N/A	N/A	N/A

² Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>). This database reports acute fish and freshwater invertebrate endpoints of > 100 mg/L and 89 mg/L, respectively and aquatic plant EC₅₀s of >73 mg/L and 138 mg/L for vascular and non-vascular aquatic plants.

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source/Classification
Estuarine/marine invertebrates	Acute	TGAI 86.8%	Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	Practically non-toxic	MRID 00034702/ Acceptable
	Chronic	--	No Data	N/A	N/A	N/A
	Acute	--	No Data	No Data	N/A	--
Aquatic plants and algae	Vascular	--	No Data	N/A	N/A	--
	Non-vascular	TGAI 89.5%	Marine Diatom (<i>Skeletonema costatum</i>)	120-Hr EC ₅₀ = 0.493 mg ae/L (0.09—4.1) NOAEC = 0.011 mg ae/L Mean-measured	N/A	MRID 42774110/ Acceptable

¹ Freshwater fish are surrogates for aquatic-phase amphibians.

Table 7. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for Dicamba dimethylamine salt (PC Code 029802)

Taxonomic Group	Study Type	TGAI/TEP % Dicamba ae	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 11.5%	Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i>	96-Hr LC ₅₀ > 112.4 mg ae/L	Practically non-toxic	MRIDs 00046183 00046184/ Acceptable
Freshwater invertebrates	Acute	TEP 48.2%	Water Flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ = 1563 mg a.e./L (1270—1856)	Practically non-toxic	MRID 00028283/ Acceptable

Table 8. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba sodium salt (PC Code 029806)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 22%	Rainbow Trout (<i>Oncorhynchus mykiss</i>)	96-Hr LC ₅₀ = 111.6 mg ae/L (436.3—589.9) Nominal	Practically non-toxic	MRID 00029623/ Acceptable
Freshwater invertebrates	Acute	TEP 26.5%	Water flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ = 9.2 mg ae/L	Moderately toxic	MRID 00085935 Acceptable

Table 9. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba DGA salt (PC Code 128931)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source
Freshwater fish	Acute	TEP 40.2%	Rainbow Trout (<i>Oncorhynchus mykiss</i>) & Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ > 270.8 mg ae/L Nominal	Practically non-toxic	MRIDs 00162068 00162067/ Acceptable
Freshwater invertebrates	Acute	TEP 40.2%	Water flea (<i>Daphnia magna</i>)	48-hr EC ₅₀ > 270.8 mg ae/L	Practically non-toxic	MRID 00162069/ Supplemental — Quantitative

Table 10. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba K salt (PC Code 129043)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source (Classification)
Freshwater fish	Acute	TEP 38%	Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ = 73.2 mg ae/L Nominal	Practically non-toxic	ACCN 00258932/ Supplemental — Qualitative
Freshwater invertebrates	Acute	TEP 40.2%	Water flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ = 301 mg ae/L Nominal	Practically non-toxic	ACCN 00258983/ Supplemental — Qualitative

Table 11. Summary of the Most Sensitive Endpoints from Aquatic Toxicity Studies for dicamba IPA salt (PC Code 128944)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (95% Confidence Interval)	Acute Toxicity Classification	Source (Classification)
Freshwater fish	Acute	TEP 32.5%	Rainbow trout (<i>Oncorhynchus mykiss</i>) & Bluegill sunfish (<i>Lepomis macrochirus</i>)	96-Hr LC ₅₀ > 256 mg a.e./L Nominal	Practically non-toxic	MRIDs 00265440 00265441/ Acceptable
Freshwater invertebrates	Acute	TEP 32.5%	Water flea (<i>Daphnia magna</i>)	48-Hr EC ₅₀ > 256 mg a.e./L Nominal	Practically non-toxic	MRID 00265442/ Supplemental — Quantitative

6.2. *Effects to Terrestrial Organisms*

Tables 12-17 show the most sensitive available terrestrial toxicological data for dicamba acid and its associated salts. No terrestrial ecotoxicity data are available for the DEA-salt (PC code 029803) or the IPA-salt (PC code 128944. On an acute oral basis to birds, the toxicity of dicamba and its associated salts ranges from practically non-toxic to moderately toxic, with dicamba acid having the most sensitive endpoint. No acute oral data is available for dicamba's toxicity to passerine birds, which have the potential to be more sensitive than the tested surrogate species (bobwhite quail). On an acute dietary basis to birds, treatment-related effects and mortalities were generally not observed even at the highest tested doses, leading to non-definitive (*i.e.* greater than) LC₅₀s and sub-acute toxicity classifications of practically non-toxic to slightly toxic. The only sensitive chronic avian endpoint was for mallard ducks (21-week NOAEC of 695 mg a.e./kg-diet.) based on moderate (11-21%) inhibitions in the number of hatchlings, 14-day old chicks and 14-day old chicks as a percentage of eggs laid in the 1390 mg a.i./kg-diet treatment group compared to the control group. However, these reductions were not statistically significant and potentially could be due to natural variability. Therefore, it is possible that this endpoint may overestimate the chronic toxicity of dicamba to avian species.

Dicamba is practically non-toxic to mammals on acute oral basis. Chronic effects observed in the 2-generation rat study were based on neurotoxicity, delayed maturation of the F₀ generation, and decreased pup weight in both the F₁ and F₂ generations at 450 mg a.e./kg-diet. Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees. This is considered a major data gap.

For terrestrial plants, no acceptable data are available for TEPs with dicamba acid or any of its associated salts, with the exception of the DGA-salt. A seedling emergence and vegetative vigor study with dicamba acid (MRID 42846301), is considered supplemental due to the use of TGAI instead of TEP and since the test plants were cultivated in support media of pure sand with 0.11-0.17% organic matter rather than soil and is not representative of more typical conditions that plants exposed to dicamba may face. Though the plants in the study were bottom-watered, there is nonetheless concern that some dicamba may have leached downward in the sand, resulting in uncertainty as to the actual exposures the plants received. Therefore, new vegetative vigor data is needed for representative TEPs of each salt (other than the DGA salt) and dicamba acid as well as seedling emergence data for dicamba acid. For dicamba DGA salt, the submitted seedling emergence and vegetative vigor studies were acceptable (MRIDs 47815101 and 47815102), but new vegetative vigor data are needed for lettuce only, due to poor performance of lettuce control plants in the available vegetative vigor study.

Table 18 shows the available terrestrial toxicological data for dicamba's metabolite, DCSA. Mammalian data indicate that DCSA has similar acute toxicity as parent dicamba, but is significantly more toxic on a chronic basis with statistically significant inhibitions (6-9%) in 14-21 post-natal days pup weight at the 37 mg/kg/d treatment group, relative to controls, and a corresponding NOAEL of 4 mg/kg/d based on male pre-mating doses. A recent benchmark dose analysis conducted by HED (USEPA, 2016f) determined benchmark doses based on both male pre-mating doses and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup

body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. In the risk assessment, EPA will use the 8 mg/kg/d NOAEL based on dam lactation doses as the chronic mammalian endpoint.

No chronic data are available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). In the absence of additional data, as a conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch. However, chronic avian reproduction data with DCSA would decrease the uncertainty associated with this approach.

Table 12. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba acid (PC Code 029801)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds ¹	Acute oral	86.9%	Bobwhite quail (<i>Colinus virginianus</i>)	LD ₅₀ = 188 mg a.e./kg-bw (141—250) Slope = 6.0 (2.6—9.3)	Moderately toxic	MRIDs 42918001 42774105 (Acceptable)
	Acute oral (passerine)	--	No Data	No Data	N/A	--
	Sub-acute dietary	86.8%	Bobwhite quail (<i>Colinus virginianus</i>)	8-D LC ₅₀ > 8,680 ppm a.e.	Practically non-toxic	MRID 00025391 (Acceptable)
	Chronic	86.9	Mallard duck (<i>Anas platyrhynchos</i>)	NOAEC = 695 ppm a.e. LOAEC = 1390 ppm a.e. Reduced Hatch, and Chick Survival	N/A	MRID 43814003 (Acceptable)
Mammals	Acute Oral	TGAI 99.7%	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg/kg (males) (2010-3740)	Practically non-toxic	MRID 00078444 (Acceptable)
	Acute Inhalation	TEP	Laboratory rat (<i>Rattus norvegicus</i>)	4-Hr LC ₅₀ > 5.3 mg a.e./L	IV	MRID 00263861 (Acceptable)

Taxonomic Group	Study Type	TGAI/TEP %ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Subchronic Feeding	TGAI 86.8%	Laboratory rat (<i>Rattus norvegicus</i>)	13-Wk NOEL: 500 mg/kg/d LOEL: 1000 mg/kg/day Endpoints: body wt. changes, liver effects	N/A	MRID 00128093 (Acceptable)
	Chronic (2-Generation Reproduction)	TGAI 86.9%	Laboratory rat (<i>Rattus norvegicus</i>)	NOAEL = 136 mg ae/kg-diet/day LOAEL = 450 mg a.e./kg-diet/day Endpoints: neurotoxicity, delayed maturation of F0 gen, decreased pup weight	N/A	MRID 43137101 (Acceptable)
Terrestrial Invertebrates	Acute contact (adult)	TEP % ai unknown	Honey bee (<i>Apis mellifera</i> L.)	48-hr LD ₅₀ > 90.65 µg/bee	Practically non-toxic	MRID 00036935 (Supplemental —Quantitative)
	Acute oral (adult)	--	No Data	No Data	N/A	--
	Chronic oral (adult)	--	No Data	No Data	N/A	--
	Acute larval	--	No Data	No Data	N/A	--
	Chronic larval	--	No Data	No Data	N/A	--
Terrestrial plants	Seedling Emergence	--	No Data	No Data	N/A	MRID 42846301 (Supplemental —Qualitative)
		--	No Data	No Data	N/A	MRID 42846301 (Supplemental —Qualitative)
	Vegetative Vigor	--	Monocot – No Data	No Data	N/A	--
		--	Dicot – No Data	No Data	N/A	--

¹ Birds are considered a surrogate for terrestrial phase amphibians and reptiles

Table 13. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba DMA-salt (PC Code 029802)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	TEP 11.5%	Mallard Duck <i>Anas platyrhynchos</i>	14-D LD ₅₀ > 282 a.e./kg-bw	Practically non-toxic	MRIDs 00046180 (Acceptable)
	Sub-acute dietary	TEP 48.2%	Bobwhite quail <i>Colinus virginianus</i> & Mallard Duck <i>Anas platyrhynchos</i>	8-D LC ₅₀ > 2,185 ppm a.e.	Practically non-toxic	MRIDs 00034693 00022527 (Acceptable)

Table 14. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba Na-salt (PC Code 029806)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Sub-acute dietary	TEP 26.5%	Bobwhite quail <i>Colinus virginianus</i>	8-D LC ₅₀ > 2,409 ppm a.e.	Slightly toxic	MRID 00068785 (Acceptable)

Table 15. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba DGA-salt (PC Code 128931)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	No Data ¹	--	N/A	No Data	No Data

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Sub-acute dietary	TEP 40%	Bobwhite quail <i>Colinus virginianus</i> & Mallard Duck <i>Anas platyrhynchos</i>	8-D LC ₅₀ > 609 ppm a.e.	Slightly Toxic	MRIDs 00162071 00162072 (Acceptable)
Terrestrial plants	Seedling Emergence	TEP 40.3%	Monocot – Onion (<i>Allium cepa</i>)	EC ₂₅ = 1.68 lb ae/A NOAEC = 0.64 lb ae/A	N/A	MRID 47815101 (Acceptable)
		TEP 40.3%	Dicot – Soybean (<i>Glycine max</i>)	EC ₂₅ = 0.170 lb ae/A NOAEC = 0.0702 lbs ae/A	N/A	
	Vegetative Vigor	TEP 40.3%	Monocot – Onion (<i>Allium cepa</i>)	EC ₂₅ = 0.472 lbs ae/A EC ₀₅ = 0.137 lbs ae/A	N/A	MRID 47815101 (Acceptable)
		TEP 40.3%	Dicot – Soybean (<i>Glycine max</i>)	EC ₂₅ = 0.000513 lb ae/A NOAEC = 0.000261 lb ae/A	N/A	

¹ Previously, a study with the bobwhite quail (MRID 00162070) was deemed to be acceptable with an LD₅₀ of 387.2 ppm a.e. However, regurgitation occurred at several doses, including the lowest dose (117 ppm a.e.). The regurgitation did not follow a dose response, and this study has been downgraded to invalid.

Table 16. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba K-salt (PC Code 129043)

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Birds	Acute oral	TEP 38%	Bobwhite quail (<i>Colinus virginianus</i>)	14-D LD ₅₀ = 235 mg a.e./kg-bw	Moderately toxic	MRID 00261466 (1986) Supplemental-- Quantitative

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
	Sub-acute dietary	TEP 38%	Bobwhite quail (<i>Colinus virginianus</i>) & Mallard duck (<i>Anas platyrhynchos</i>)	8-D LC ₅₀ > 1,822 ppm a.e.	Slightly toxic	MRIDs 00261465 00261466 (Supplemental--Quantitative)

Table 17. Summary of the Most Sensitive Endpoints from Terrestrial Toxicity Studies for Dicamba's Metabolite, DCSA.

Taxonomic Group	Study Type	TGAI/TEP % ai	Surrogate Species	Toxicity Value (all units in terms of measured active ingredient)	Acute Toxicity Classification	Source (Classification)
Mammals	Acute Oral	TGAI 99.7%	Laboratory rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 mg/kg (males)	Practically non-toxic	MRID 47899504 (Acceptable)
	Chronic (2-Generation Reproduction)	TGAI 86.9%	Laboratory rat (<i>Rattus norvegicus</i>)	NOAEL = 8 mg ac/kg-diet/day LOAEL = 78 mg a.e./kg-diet/day, using female lactation doses Endpoints: decreased pup weight	N/A	MRID 47899517 (Acceptable)

6.3. Ecological Incidents

A preliminary review on May 17, 2016 of the Ecological Incident Information System (EIIS, version 2.1.1), which is maintained by the Agency's Office of Pesticide Programs and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 178 reported ecological incidents in the United States associated with the use of the dicamba acid and salt active ingredients (summarized by certainty in **Table 18**). This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents

classified as ‘unlikely’ the result of or ‘unrelated’ to dicamba will not be included in this Problem Formulation or the ecological risk assessment conducted for Registration Review.

All of the dicamba incidents in these databases, excluding those classified as ‘unlikely’ or ‘unrelated’, occurred between 1991 and 2013. Six (3%) of the dicamba incidents involved aquatic animals, one (<1%) involved terrestrial animals and 171 (96%) involved plants. The certainty categories regarding the likelihood that the use of dicamba caused the 178 incidents ranged from unlikely (9 incidents), possible (104 incidents), probable (69 incidents) to highly probable (5 incidents). 53 of the incidents were considered registered uses at the time of the incident, 43 involved misuses, and the legality of the use was undetermined in 82 incidents.

EPA is also aware of additional recent incident information (2012—2015), that has not yet been included in EIIS, relating to the use of dicamba on dicamba-tolerant soybean and cotton crops. Information relating to the current knowledge and understanding surrounding these incidents is described in the Section 3 New Use assessment for dicamba on dicamba-tolerant cotton (D404823; USEPA, 2016a) and the addendum to Section 3 New Use assessment for dicamba on dicamba-tolerant soybean (D426789, USEPA, 2016b)

Table 18. Incidents found in the Ecological Incident Information System across all salts and dicamba acid

Incident Type	Use Type	Certainty				
		All (excluding unlikely)	Unlikely	Possible	Probable	Highly Probable
Fish	Misuse	0	0	0	0	0
	Registered Use	1	0	1	0	0
	Undetermined	5	1	5	0	0
Wildlife	Misuse	0	0	0	0	0
	Registered Use	0	0	0	0	0
	Undetermined	1	2	1	0	0
Plants	Misuse	43	1	18	21	4
	Registered Use	52	2	19	33	0
	Undetermined	76	3	60	15	1
Total		178	9	104	69	5

In addition to the incidents recorded in EIIS and AIMS, additional incidents have been reported to the Agency in aggregated incident reports. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as ‘minor fish and wildlife’ (W-B), ‘minor plant’ (P-B), and ‘other non-target’ (ONT) incidents. ‘Other non-target’

incidents include reports of adverse effects to insects and other terrestrial invertebrates. For dicamba, registrants have reported 24 minor fish and wildlife incidents, 8340 minor plant incidents, and 3 other non-target incidents. Unless additional information on these aggregated incidents become available, they will be assumed to be representative of registered uses of dicamba in the risk assessment.

7. Exposure Pathways of Concern

The environmental fate properties and use patterns of dicamba indicate that direct spray onto food residues, spray drift, leaching to ground water, volatilization, and runoff represent potential transport mechanisms of dicamba to aquatic and terrestrial organisms.

Drinking water and inhalation exposure pathways were screened using the SIP (Screening Imbibition Program) and STIR (Screening Tool for Inhalation Risk) screening methods. Drinking water with dicamba or DCSA residues was found to be a potential exposure pathway of concern (LOC exceedances are expected) on an acute and chronic basis for birds and mammals. SIP and STIR are described in detail at:
<http://www.epa.gov/oppefed1/models/terrestrial/index.htm>.

The Screening Tool for Inhalation Risk (STIR v.1.0) was used to assess the potential for risk to birds and mammals through inhalation exposure. The exposure pathways that are assessed by this tool include both droplet inhalation and vapor-phase inhalation. STIR, used in the problem formulation phase, is intended to determine if exposure is likely and not whether the potential for risk exists based on a chemical's maximum application rate, molecular weight and vapor pressure and the available mammalian acute oral and inhalation toxicity endpoints and avian acute oral endpoint (an adjusted avian inhalation toxicity endpoint is estimated from the mammalian toxicity data). If STIR predicts that exposure is likely, additional inhalation data may be necessary to adequately assess risk due to the inhalation exposure pathway. Based on STIR screening analysis, inhalation is not considered likely to be a significant route of exposure for birds and mammals from vapor exposure, but for birds could potentially be a significant route of exposure where applications are greater than 2.1 lbs a.e./A. However, this concern is based on the assumption that the highest test concentration from the available mammalian inhalation toxicity test (5.3 mg/L) results in 50% mortality, but as this is a non-definitive (>) endpoint, it is likely highly conservative. Given that few maximum dicamba application rates are greater than 2.1 lbs a.e./A, and the mammalian inhalation endpoint was non-definitive and therefore is likely highly conservative, no additional inhalation data is requested. See **Appendix B** for STIR inputs and outputs.

The Screening Imbibition Program (SIP 1.0, Released June 15, 2010) was used to calculate an upper bound estimate of exposure using dicamba's and DCSA's solubility in water (6100 mg/L for dicamba, 2112 mg/L for DCSA), the most sensitive acute and chronic avian toxicity endpoints (bobwhite acute LD₅₀ of 188 mg/kg-bw, mallard NOAEC of 695 mg/kg-diet) and the most sensitive acute and chronic mammalian toxicity endpoints (male laboratory rat acute LD₅₀ of 2740 mg/kg-bw and rat chronic NOAEL of 136 mg/kg-bw for dicamba, acute and chronic rat endpoints of 2641 mg/kg-bw and 8 mg/kg-bw for DCSA). Drinking water exposure alone to either dicamba or DCSA residues was determined to be a potential pathway of concern for

mammalian and avian species on both an acute and chronic basis. This pathway will be explored further with the development of SIP v.2.0 in the Ecological Risk Assessment for dicamba. The chronic avian data for DCSA expected to be requested in the DCI will also be used in this assessment of drinking water exposure. For a sample of the output generated by SIP v.1.0, please see **Appendix B**. Detailed information about the SIP v.1.0, as well as the tool, can be found on the EPA's website at http://www.epa.gov/pesticides/science/models_pg.htm#terrestrial.

8. Analysis Plan

8.1. Stressors of Concern

8.1.1. Ecological Risk Assessment

The stressors of concern are parent dicamba (as the acid, salts and esters) and the degradate 3,6-DCSA (dichlorosalicylic acid).

8.1.2. Drinking Water – Human Health

The drinking water assessments conducted to support the registration review human health risk assessments of dicamba will address the parent compound only as acid equivalents across the various formulations, in surface and ground waters. The degradate, 3,6-DCSA will be assessed separately.

8.2. Measures of Exposure

EFED will use standard available models to evaluate potential exposures to aquatic and terrestrial organisms as described at http://www.epa.gov/pesticides/science/models_db.htm.

Available Monitoring Data

The USGS Water Quality Portal (<http://waterqualitydata.us/portal/>) was queried on 05/18/16 for monitoring data using the search term “dicamba.” 50,458 records were returned for water and sediment analyses primarily from the STORET and NWIS databases. The vast majority of these records appeared to be “non-detect” or “below reporting limit” for dicamba, as expected. An analysis of these data will be done in the risk assessment.

Aquatic Exposure Modeling

The models used to predict aquatic estimated environmental concentrations (EECs) is the Pesticides in Water Calculator (PWC) which incorporates PRZM and the Variable Volume Water Model (VVWM) for surface water and PRZM-GW for ground water. These are publicly available at: <http://www.epa.gov/oppefed1/models/water/index.htm>. Modeling will be conducted using the acid equivalent approach, plus a Total Toxic Residue including 3,6-DCSA if needed.

Terrestrial Exposure Modeling

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX model (version 1.5.2, March 2012). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenaga 1972). The Fletcher *et al.* (1994) modifications to the Kenaga nomograph are based on measured field residues from 249 published research papers, including information on 118 species of plants, 121 pesticides, and 17 chemical classes.

In recent risk assessments (USEPA, 2016a-b), EFED has used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value of **8.4 days**, which will be used in the registration review risk assessment.

Screening level calculations have suggested that the drinking water exposure pathway may be a significant concern for birds and mammals and will be further evaluated at the time of risk assessment with SIP v2.0.

EECs for terrestrial plants inhabiting dry and wetland areas are derived using TerrPlant (version 1.2.2, December 2006). This model uses estimates of pesticides in runoff and in spray drift to calculate EECs. EECs are based upon solubility, application rate and minimum incorporation depth in addition to type of formulation and method of application. The Agency is currently developing a replacement model for TerrPlant. If the replacement has been approved prior to the initiation of the risk assessment, this new model will be used instead.

Two spray drift models, AgDisp and AgDRIFT, are used to assess exposures of aquatic and terrestrial organisms to dicamba deposited in terrestrial and aquatic habitats by spray drift. AgDRIFT (version 2.1.1; dated 12/29/2011) is the model most commonly used to simulate spray drift into terrestrial and aquatic environments from aerial and ground applications. AgDisp (version 8.13; dated 12/14/2004) (Teske and Curbishley, 2003) is used when a parameter needs to be modeled that is not available in AgDRIFT. Spray drift analysis will be an important part of the analysis in defining the potential area of effects to non-target species.

8.3. Measures of Effect

Toxicity data presented in Section 6 of this problem formulation will be used to calculate risk quotients. Any additional information submitted by the registrant or found in the open literature prior to conduct of the risk assessment will also be considered. The open literature studies are identified using EPA's ECOTOXicology database (ECOTOX) (USEPA, 2009), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of both sources of data can also provide insight into the direct and indirect effects of pesticides on biotic communities from loss of species that are sensitive to the chemicals and from changes in structure and functional characteristics of the affected communities.

9. Endangered Species Assessments

Consistent with the Agency's responsibility under the Endangered Species Act (ESA), the Agency will evaluate risks to federally listed threatened and/or endangered (listed) species from registered uses of pesticides in registration review. The process for evaluating potential risks to listed species is further described at <https://www.epa.gov/endangered-species>. Three endangered species assessments were recently conducted for the post-emergent use of dicamba DGA salt on dicamba-tolerant soybean and cotton (USEPA, 2016c-e. D416416+, D422305, D425049) covering listed species in 34 states.

10. Endocrine Disruptor Screening Program

As required by FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of the Preliminary Problem Formulation for Registration Review (DP Barcode 426710), EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), dicamba is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2

testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013^[1] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. Dicamba is not on either the first or second list. For further information on the status of the EDSP, the policies and procedures, the initial list of 67 chemicals or the overview of the second list of 109 chemicals, the test guidelines and the Tier 1 screening battery, please visit our website: <http://www.epa.gov/endo/>.

11. Preliminary Identification of Data Gaps

11.1. Environmental Fate

Table 19 identifies environmental fate studies by MRID that offer data for each guideline requirement, as well as study classifications and whether or not further data are needed in order to support risk assessment.

Table 19. Submitted Environmental Fate Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Comments, Justification and Assumptions EPA will Make in Absence of Data
835.2120	Hydrolysis	40547902 40335501 43245208	Acceptable	No	
835.2240	Aqueous photolysis	42774102	Acceptable	No	
835.2410	Soil photolysis	42774103	Acceptable	No	
835.4100	Aerobic Soil Metabolism	43245207 49067702 48718002	Acceptable Supplemental Supplemental	Yes	(One US soil) (Two European soils) (Four US soils) Acceptable data on more than one US soil is requested
835.4200	Anaerobic soil metabolism	40547906 43245208	Acceptable	No	
835.4300	Aerobic aquatic metabolism	43758509	Supplemental	Yes	Acceptable data on more than one system is requested.
835.4400	Anaerobic aquatic metabolism	43245208	Acceptable	No	

^[1] See <http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0477-0074> for the final second list of chemicals.

OCSPP Guideline	Data Requirement	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Comments, Justification and Assumptions EPA will Make in Absence of Data
835.1230 835.1240	Adsorption/ desorption and leaching	42774101 43095301 (DCSA)	Acceptable Supplemental	No	
835.6100	Terrestrial field dissipation	40547908 42754101 42754102 42754103 44373708 48718005 43361506 43361507 43651405 43651407 43651408	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental	No	K salt K salt Na and DGA salts DGA salt DMA salt DGA salt Na salt
835.1410	Laboratory Volatility	41966602	Acceptable	Yes	Study is for dicamba K salt. Data on all formulations proposed for use on dicamba-tolerant crops required.
835.8100	Field Volatility	49022501 49067704	Supplemental Pending	Yes	Requested for each registered salt and ester formulation intended for use on dicamba-tolerant crops.
840.1100	Spray Drift Droplet Spectrum	49671601 49671602 49067704	Pending	Yes	Requested for each formulation intended for use on dicamba-tolerant crops.
840.1200	Spray Drift Field Deposition	49770301	Pending	Yes	Requested for each formulation intended for use on dicamba-tolerant crops.
850.1730	Fish BCF	--	Waived	No	Bioconcentration in fish is not expected based on dicamba's solubility and pKa.
850.6100	Water and Soil Environmental Chemistry Methods			Yes	
850.6100	Soil and Water Independent Laboratory Validation			Yes	
835.6100	Foliar dissipation			Yes	Data are needed for parent dicamba and for DCSA

11.2. Effects

Table 20 and **Table 21** identify ecological effects studies by MRID that offer data for each guideline requirement, as well as study classifications and whether or not further data are needed in order to support risk assessment.

Table 20. Submitted Aquatic Ecological Effects Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Current Additional Data Need
850.1010	Freshwater invertebrate acute toxicity	029801	40098001	Supplemental--Quantitative	No	--
		029802	00028283	Acceptable	No	
		029806	00085935	Acceptable	No	
		128931	00162069	Supplemental—Quantitative	No	
		128944	00265442	Supplemental--Quantitative	No	
		129043	00258983	Supplemental—Qualitative	No	
850.1025 850.1035 850.1045 850.1055	Saltwater invertebrate acute toxicity	029801	00034702	Acceptable	No	No data are available for dicamba's toxicity to estuarine/marine mollusks. Data following the 850.1025 (shell deposition) guideline should be submitted using TGAI dicamba acid.
		029801	No Data	N/A	Yes	
850.1075	Freshwater fish acute toxicity	029801	40098001	Supplemental--Quantitative	No	--
		029802	00263000 00046183 00046184	Acceptable	No	
		029806	00029623	Acceptable	No	
		128931	00162068 00162067	Acceptable	No	
		128944	00265440 00265441	Acceptable	No	
		129043	Acc# 00258932	Supplemental—Quantitative	No	
850.1075	Saltwater fish acute toxicity	029801	00025390	Acceptable	No	--
850.1300	Freshwater invertebrate life cycle	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to freshwater invertebrates. A freshwater invertebrate life cycle study should be submitted using a species for which acute data is available using TGAI dicamba acid. Additionally, due to empirical mammalian data and predicted chronic toxicity to aquatic invertebrates, chronic daphnid data should be submitted for DCSA.
		Metabolite DCSA	No Data	N/A	Yes	

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed to conduct risk assessment?	Current Additional Data Need
850.1350	Saltwater invertebrates life cycle	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to saltwater invertebrates. A saltwater invertebrate life cycle study should be submitted using a species for which acute data is available using TGAI dicamba acid.
850.1400	Freshwater fish early-life stage	029801	No Data	N/A	Yes	No data are available for chronic effects of dicamba to freshwater fish. A freshwater fish early life stage study should be submitted using a species for which acute data is available using TGAI dicamba acid. Additionally, due to empirical mammalian data and predicted chronic toxicity to fish, chronic fish data should be submitted for DCSA with the same fish species used to fulfill the 850.1400 guideline with dicamba acid.
		Metabolite DCSA	No Data	N/A	Yes	
850.1400	Saltwater fish early-life stage	029801	No Data	N/A	No	No data are available for chronic effects of dicamba to saltwater fish. A saltwater fish early life stage study should be submitted using a species for which acute data is available using TGAI dicamba acid
850.1500	Fish life cycle	029801	No Data	N/A	No	--
850.4400	Aquatic plant Toxicity Test using Lemna spp.	029801	42774111	Invalid	Yes	Conditions in controls of the submitted study were inadequate to represent typical environmental conditions and may have adversely impacted control performance. A new study is needed using TGAI dicamba acid.
850.4500	Algal toxicity	029801	42774110	Acceptable	No	--
		029801	42774107	Acceptable	No	
		029801	42774108	Acceptable	No	
850.4550	Cyanobacteria	029801	42774109	Acceptable	No	--

Table 21. Submitted Terrestrial Ecological Effects Data for Dicamba (various PC codes)

OCSPP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.2100	Avian oral toxicity	029801	42774106 42774105	Acceptable	Yes	A passerine acute oral study is required as dicamba is moderately toxic on an acute basis to bobwhite quail and passerine species may be more sensitive than other taxa.
		029801	No Data	N/A		
		029802	00073275 00046180	Acceptable		
		128931	00263863	Invalid		
		129043	00261466	Supplemental-- Quantitative		
850.2200	Avian dietary toxicity	029801	42918001 42774105	Acceptable	No	--
		029802	00034693 00022527	Acceptable		
		029806	00068785	Acceptable		
		128931	00162071 00162072	Acceptable		
		129043	00261465 00261466	Supplemental-- Quantitative		
850.2300	Avian reproduction	029801	43814003	Acceptable	No	Chronic avian data (mallard duck preferred) with the metabolite DCSA is needed for the risk assessment. In the absence of chronic data, EPA will consider alternative approaches (<i>i.e.</i> using the difference between the chronic mammalian studies with dicamba and DCSA and comparing to the chronic mallard endpoint with dicamba acid.)
		Metabolite DCSA	No Data	N/A	Yes	
850.3020	Honey bee acute contact toxicity (Tier 1)	029801	00036935	Supplemental— Quantitative	No	--

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.3030	Honey bee residue on foliage (Tier 1)	029801	No Data	N/A	No	Data have not been submitted to fulfill this guideline. A data gap was not identified as these data are not necessary for risk assessment at this time since dicamba's acute contact LD ₅₀ was greater than the trigger of 11 µg/bee.
Non-guideline	Honey bee adult acute oral toxicity (Tier 1)	029801	No Data	N/A	Yes	No data is available assessing the oral exposure route for terrestrial invertebrates. A study should be submitted using TGAI dicamba acid. Although EPA has not developed a guideline for this study, OECD TG 213 may be used to satisfy the guideline requirement.
Non-guideline	Honey bee adult chronic oral toxicity (Tier 1)	029801	No Data	N/A	Yes	No data is available assessing the oral exposure route for terrestrial invertebrates. A study should be submitted using TGAI dicamba acid. Neither EPA nor OECD have an approved guideline for this study, but draft OECD guidance is in development. A protocol should be submitted prior to study initiation.
Non-guideline	Honey bee larval acute oral toxicity (Tier 1)	029801	No Data	N/A	Yes	In addition to the adult honey bee data gaps identified above, data is needed for the additional

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
Non-guideline	Honey bee larval chronic oral toxicity (Tier 1)	029801	No Data	N/A	Yes	honey bee life stage of larvae to complete the risk assessment for pollinators. Although EPA has not developed a guideline for these studies, OECD TG237 may be used to assess acute oral effects on larvae. Chronic (repeat dose) study guidance for assessing chronic oral toxicity to honey bee larvae is currently in development by OECD. A protocol should be submitted prior to study initiation.
Non-guideline	Magnitude of Residues in Pollen and Nectar	029801	No Data	N/A	Yes	Data have not been submitted to fulfill this guideline. Results from lower tier studies should inform the conduct of the field test to address remaining uncertainties. Pending the results of lower tier studies (adult honey bee acute oral, chronic adult honey bee, acute and chronic larval), magnitude of residue studies may not be needed to complete the risk assessment for pollinators. A protocol should be submitted prior to test initiation.

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
850.3040	Field testing for pollinators (Tier 2)	029801	No Data	N/A	Yes	Data have not been submitted to fulfill this guideline. Results from lower tier studies should inform the conduct of the field test to address remaining uncertainties. Pending the results of lower tier studies (adult honey bee acute oral, chronic adult honey bee, acute and chronic larval), a field testing study may not be needed to complete the risk assessment for pollinators. A protocol should be submitted prior to test initiation.
850.4100	Seedling Emergence and Seedling Growth	029801	42846301	Supplemental--Qualitative	Yes	The submitted data for dicamba acid were with TGAI and were conducted on plants grown in pure sand. New data are needed for representative TEP for dicamba acid using the standard suite of 10 species.
		029802	No Data	N/A	No	
		029803	No Data	N/A	No	
		029806	No Data	N/A	No	
		128931	47815101	Acceptable	No	
		128944	No Data	N/A	No	
		129043	No Data	N/A	No	
850.4150	Vegetative Vigor	029801	42846301	Supplemental--Qualitative	Yes	The submitted data for dicamba acid were with TGAI and were conducted on plants grown in pure sand. New data are needed for representative TEP for dicamba acid and all salts (except for DGA-salt), with 7 species (onion + 6 dicot species).
		029802	No Data	N/A	Yes	
		029803	No Data	N/A	Yes	
		029806	No Data	N/A	Yes	
		128944	No Data	N/A	Yes	
		129043	No Data	N/A	Yes	

OCSP Guideline	Data Requirement	PC Code	Submitted Studies (MRID)	Study Classifications	Are data needed for risk assessment?	Current Additional Data Need
		128931	47814102	Supplemental—Quantitative	Yes ¹	¹ For DGA-salt, acceptable data is available for all species except for lettuce, for which data is still needed.

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USEPA, 2016d. Addendum to Dicamba Diglycolamine (DGA) Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States (Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas). D422305. Environmental Fate and Effects Division, Office of Pesticide Programs, Office of Chemical Safety and Pollution Prevention. Washington, DC. March 24, 2016

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Appendix A. Maximum Use Rate Information for Dicamba and its Associated Salts

Table A1. Maximum Labeled Use Rate Information for Dicamba Acid (PC Code 029801)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
GRASS (GROWN FOR SEED)	1.52	2.95	NS	NS	Broadcast
GRASS (FORAGE/FODDER/HAY), PASTURES, RANGELAND	1.50	3.01	2	30 day	Spot treatment
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE, AGRICULTURAL UNCULTIVATED AREAS	1.5	1.88	2	NS	Spot treatment, banded, broadcast (aerial, sprayer)
SOYBEANS	1.47	2.95	NS	NS	Broadcast, Spot Treatment
SUGARCANE	1.47	2.95	NS	NS	Broadcast (aerial, sprayer), banded, spot treatment, Wipe-on
ORNAMENTAL LAWNS & TURF, SOD FARMS	1.47	1.47	NS	30 day	Broadcast (aerial, sprayer), spot treatment, wipe-on
FOREST TREE MANAGEMENT/FOREST PEST MANAGEMENT	1.03	1.03	1	N/A	Broadcast (aerial & ground), Spot Treatment
CORN	0.74	1.10	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
ASPARAGUS	0.74	0.74	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
SORGHUM, WHEAT	0.37	0.74	NS	NS	Banded, Spot Treatment, Broadcast (aerial, sprayer)
BARLEY	0.37	0.55	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
COTTON	0.37	0.37	NS	NS	Broadcast (aerial, sprayer), banded, spot treatment
OATS, PROSO MILLET, TRITICALE	0.18	0.18	NS	NS	Banded, broadcast (aerial, sprayer), spot treatment, wipe-on
GOLF COURSE, RECREATION & RESIDENTIAL LAWNS	0.12	0.24	2	30 day	Broadcast (spreader)

NS-Not Specified

Table A2. Maximum Labeled Use Rate Information for Dicamba DMA salt (PC Code 029802)

Use Site	Maximum Rate (lbs a.e./Acre)		Max. No. of Apps/Year	Min. App. Interval	Application Methods/Comments
	Single	Annual			
NONAGRICULTURAL UNCULTIVATED AREAS/SOILS, AGRICULTURAL/FARM PREMISES, PASTURES, RANGELAND	2.42	2.42	NS	NS	Spot treatment
HAY (SILAGE)	2.42	2.42	NS	NS	Banded, spot treatment
SUGARCANE	2.42	2.42	NS	NS	Banded, Broadcast (aerial & ground), spot treatment, wipe-on
ORNAMENTAL SOD FARM (TURF)	2.35	2.35	NS	NS	Spot treatment
ORNAMENTAL LAWNS AND TURF	2.00	NS	2	30 days	Cut stem treatment
NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS	1.65	1.65	1	30 days	Spot treatment
AGRICULTURAL CROPS/SOILS (UNSPECIFIED), AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.21	2.42	NS	NS	Spot treatment, Broadcast (aerial, ground), Wipe-on.
GRASSES GROWN FOR SEED	1.21	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
GRASS FORAGE/FODDER/HAY	0.83	1.65	2	30 days	Spot treatment
CORN	0.60	0.91	NS	14 days	Banded, Broadcast (aerial, ground), Spot treatment, Wipe-on
ASPARAGUS	0.60	0.60	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
WHEAT	0.53 or 0.15	0.74 or 2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground). Max 2.42 lb/A annual rate is only for the lower max application rate (0.15 lb/A single)

Use Site	Maximum Rate (lbs a.e./Acre)		Max. No. of Apps/Year	Min. App. Interval	Application Methods/Comments
	Single	Annual			
HOUSEHOLD/DOMESTIC DWELLINGS OUTDOOR PREMISES, ORNAMENTALS, PATHS/PATIOS, PAVED AREAS (PRIVATE ROADS/SIDEWALKS)	0.49	NS	2	NS	Spot treatment, Spot soil treatment
SORGHUM	0.42	NS	1	N/A	Banded, Spot treatment, Broadcast (aerial, ground)
SORGHUM	0.30	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground)
COTTON	0.30	NS	2	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
RECREATIONAL AREAS/LAWNS	0.22	NS	2	30 days	Broadcast (spreader)
GOLF COURSE TURF	0.19	NS	2	30 days	Spot treatment
BARLEY, OATS	0.15	2.42	NS	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
TRITICALE	0.15	NS	2	NS	Banded, Spot treatment, Broadcast (aerial, ground), Wipe-on.
COMMERCIAL/INDUSTRIAL LAWNS	0.09	NS	2	30 days	Spot treatment, broadcast (ground)

NS-Not Specified

Table A3. Maximum Labeled Use Rate Information for Dicamba DEA-salt (PC Code 0291803)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
SOYBEANS	1.00	NS	2	30 days	Spot treatment

Table A4. Maximum Labeled Use Rate Information for Dicamba Na-salt (PC Code 0291806)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
GRASSES GROWN FOR SEED	2.21	NS	NS	NS	Broadcast (aerial, ground)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.25	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SOYBEANS, SUGARCANE	1.25	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment
AGRICULTURAL/FARM PREMISES, HAY (SILAGE), NONAGRICULTURAL UNCULTIVATED AREAS/SOILS, ORNAMENTAL SOD FARM (TURF), PASTURES, RANGELAND,	1.25	1.25	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SMALL GRAINS	1.10	2.21	NS	NS	Broadcast (aerial, ground)
CORN	0.63	0.89	NS	14 days	Banded, Broadcast (aerial, ground), Wipe-on
ASPARAGUS	0.63	0.63	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded, Wipe-on
WHEAT	0.63	0.63	NS	NS	Wipe-on treatment
COTTON	0.31	2.51	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
SORGHUM	0.31	0.63	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
BARLEY	0.31	0.44	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded
GRASS FORAGE/FODDER/HAY	0.28	0.28	NS	NS	Broadcast (ground), Spot treatment
OATS, TRITICALE	0.16	0.16	NS	NS	Banded, Broadcast (aerial, ground), Spot treatment, Wipe-on
PROSO MILLET	0.14	0.14	NS	NS	Broadcast (aerial, ground)

Table A5. Maximum Labeled Use Rate Information for Dicamba DGA-salt (PC Code128931)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
NONAGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/HEDGEROWS, PASTURES,	3.05	3.05	NS	NS	Spot Treatment, Broadcast (aerial, ground), Banded, Wipe-on, Soil treatment, Spot soil

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
RANGELAND, SUGARCANE					
FOREST TREES (ALL OR UNSPECIFIED)	2.95	2.95	NS	NS	Broadcast (aerial, ground)
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	1.53	3.05	NS	NS	Spot Treatment, Broadcast (aerial, ground), Wipe-on, Banded, Spot soil treatment
GRASSES GROWN FOR SEED	1.53	3.05	NS	NS	Banded (ground), Spot Treatment, Broadcast (aerial, ground), Wipe-on
SOYBEANS	1.53	3.05	NS	NS	Banded, Spot Treatment, Broadcast (aerial, ground)
GOLF COURSE TURF	1.53	2.95	NS	NS	Broadcast (aerial, ground), Spot treatment (aerial, ground)
GRASS FORAGE/FODDER/HAY,	1.53	2.90	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded, Wipe-on, Basal bark treatment, Spot soil
ORNAMENTAL LAWNS AND TURF, ORNAMENTAL SOD FARM (TURF)	1.53	2.95	NS	30 days	Banded (aerial, ground), broadcast (aerial, ground), spot treatment, wipe-on
CORN, COTTON	1.48	2.98	NS	NS	Broadcast (aerial, ground), spot treatment, wipe-on, Banded
AGRICULTURAL RIGHTS-OF-WAY/FENCEROWS/H EDGEROWS, INDUSTRIAL / CONSTRUCTION AREAS (OUTDOOR)	1.48	2.95	NS	NS	Low volume spray (concentrate), high volume spray (dilute), Broadcast (aerial), Spot treatment
RECREATIONA AREA LAWNS	1.48	2.95	NS	30 days	Broadcast (aerial, ground)
ASPARAGUS	0.76	0.76	NS	NS	Broadcast (aerial, ground), Spot treatment, Banded (ground), Wipe-on
SMALL GRAINS	0.76	NS	NS	NS	Broadcast (aerial, ground), Spot treatment, Wipe-on, Banded
SORGHUM	0.38	2.98	NS	NS	Banded, Broadcast (aerial, ground), Spot treatment
WHEAT	0.38	0.76	NS	NS	Broadcast (aerial, ground), Spot treatment, Wipe-on, Banded
BARLEY	0.38	0.57	NS	NS	Broadcast (aerial, ground), Spot treatment (aerial, ground), Banded, Wipe-on
OATS, TRITICALE	0.19	0.19	NS	NS	Banded (aerial, ground), Broadcast (aerial, ground), Spot treatment, Wipe-on

Table A6. Maximum Labeled Use Rate Information for Dicamba IPA-salt (PC Code 128944)

Use Site	Max Rate (lbs a.e./Acre)		Max. No. of Apps per Year	Min. App. Interval	Application Methods
	Single	Annual			
COTTON	1.28	1.60	NS	NS	Broadcast (aerial, sprayer), Spot treatment
AGRICULTURAL FALLOW/IDLELAND / CONSERVATION RESERVE	0.35	0.35	NS	NS	Broadcast (aerial, ground), Spot treatment (ground), Spray (aerial, ground)
CORN	0.32	NS	2	14 days	Broadcast (aerial, sprayer), Directed spray, Spray (aerial, ground), Spot treatment
SMALL GRAINS	0.26	NS	NS	NS	Broadcast (aerial, sprayer), Spot treatment
WHEAT	0.23	NS	2	30 days	Spray (aerial, ground), low volume spray—concentrate (aerial, ground), Spot treatment
AGRICULTURAL/FARM PREMISES, FENCEROWS/HEDGE ROWS	0.22	NS	2	NS	Broadcast (ground)
BARLEY	0.22	NS	NS	NS	Spray (aerial, ground), Low volume spray—concentrate (aerial, ground)
OATS	0.16	NS	2	30 days	Spray (aerial, ground), low volume spray—concentrate (aerial, ground), Spot treatment
SORGHUM	0.16	NS	2	30 days	Spray (aerial, ground), litter and bedding treatment, Low volume—concentrate (ground)
PASTURES, RANGELAND	0.11	NS	2	30 days	Broadcast (aerial, ground), Spot treatment
NONAGRICULTURAL RIGHTS-OF-WAY, NONAGRICULTURAL UNCULTIVATED AREAS/SOILS	0.07	NS	NS	NS	Broadcast (ground)

Appendix B- SIP and STIR Outputs

SIP—Dicamba

Table 1. Inputs

Parameter	Value
Chemical name	Dicamba
Solubility (in water at 25°C; mg/L)	6100
Mammalian LD ₅₀ (mg/kg-bw)	2740
Mammalian test species	laboratory rat
Body weight (g) of "other" mammalian species	
Mammalian NOAEL (mg/kg-bw)	136
Mammalian test species	laboratory rat
Body weight (g) of "other" mammalian species	
Avian LD ₅₀ (mg/kg-bw)	188
Avian test species	northern bobwhite quail
Body weight (g) of "other" avian species	
Mineau scaling factor	1.15
Mallard NOAEC (mg/kg-diet)	695
Bobwhite quail NOAEC (mg/kg-diet)	1390
NOAEC (mg/kg-diet) for other bird species	
Body weight (g) of other avian species	
NOAEC (mg/kg-diet) for 2nd other bird species	
Body weight (g) of 2nd other avian species	

Table 2. Mammalian Results

Parameter	Acute	Chronic
Upper bound exposure (mg/kg-bw)	1049.2000	1049.2000
Adjusted toxicity value (mg/kg-bw)	2107.5000	104.6058
Ratio of exposure to toxicity	0.4978	10.0300
Conclusion*	Exposure through drinking water alone is a potential concern for mammals	Exposure through drinking water alone is a potential concern for mammals

Table 3. Avian Results

Parameter	Acute	Chronic
Upper bound exposure (mg/kg-bw)	4941.0000	4941.0000
Adjusted toxicity value (mg/kg-bw)	135.4407	34.4807
Ratio of exposure to acute toxicity	36.4809	143.2974
Conclusion*	Exposure through drinking water alone is a potential concern for birds	Exposure through drinking water alone is a potential concern for birds

*Conclusion is for drinking water exposure alone. This does not combine all routes of exposure. Therefore, when aggregated with other routes (*i.e.*, diet, inhalation, dermal), pesticide exposure through drinking water may contribute to a total exposure that has potential for effects to non-target animals.

Table 3. STIR Inputs and Outputs

Input		
Application and Chemical Information		
Enter Chemical Name	Dicamba	
Enter Chemical Use	Reg Review (many)	

Is the Application a Spray? (enter y or n)	y		
If Spray What Type (enter ground or air)	air		
Enter Chemical Molecular Weight (g/mole)	221		
Enter Chemical Vapor Pressure (mmHg)	3.41E-05		
Enter Application Rate (lb a.i./acre)	3.05		
Toxicity Properties			
Bird			
Enter Lowest Bird Oral LD ₅₀ (mg/kg bw)	188		
Enter Mineau Scaling Factor	1.15		
Enter Tested Bird Weight (kg)	0.178		
Mammal			
Enter Lowest Rat Oral LD ₅₀ (mg/kg bw)	2740		
Enter Lowest Rat Inhalation LC ₅₀ (mg/L)	5.3		
Duration of Rat Inhalation Study (hrs)	4		
Enter Rat Weight (kg)	0.35		
Output			
Results Avian (0.020 kg)			
Maximum Vapor Concentration in Air at Saturation (mg/m ³)	4.06E-01	Exposure not Likely Significant	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	5.10E-02		
Adjusted Inhalation LD ₅₀	2.03E+00		
Ratio of Vapor Dose to Adjusted Inhalation LD ₅₀	2.51E-02		
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	2.93E-01		
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD ₅₀	1.45E-01	Proceed to Refinements	
Results Mammalian (0.015 kg)			

Maximum Vapor Concentration in Air at Saturation (mg/m ³)	4.06E-01	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	6.41E-02	
Adjusted Inhalation LD ₅₀	3.16E+02	
Ratio of Vapor Dose to Adjusted Inhalation LD ₅₀	2.03E-04	Exposure not Likely Significant
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	3.68E-01	
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD ₅₀	1.17E-03	



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *EW* 3/24/16
Elizabeth Donovan, Biologist *ED* 3/24/16
William P. Eckel, Ph.D., Senior Science Advisor *WPE* (For BE) 3-24-16
Amy Blankinship, Senior Science Advisor *AB*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II[®] XTENDFLEX[™] cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bce)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

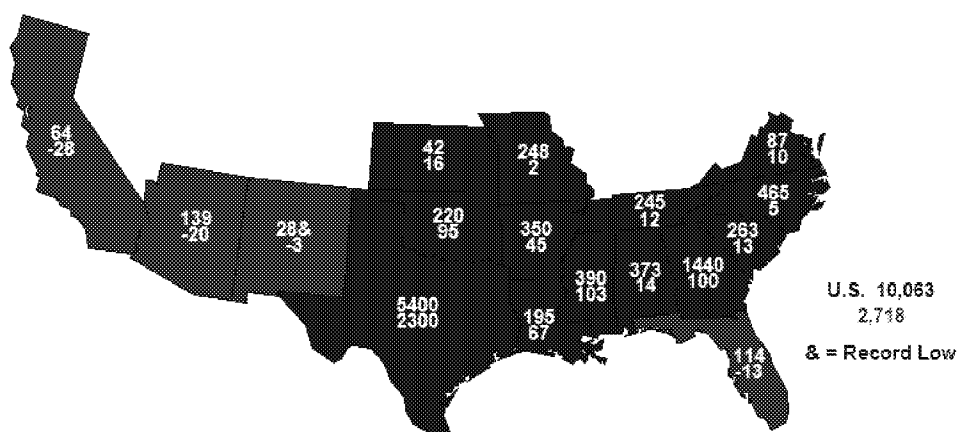
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3 and 4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _∞ (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and ***bold italicized*** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
Medium (35g)	Arthropod	0.0143	4.19	17.58	0.24
	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
Large (1000g)	Arthropod	0.0231	2.90	14.23	0.20
	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 ($>100/42 = >2.38$).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-course droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTI11004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, than given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	
Seed Treatment? (Check if yes)	<input type="checkbox"/>	Seeding Rate (lbs/acre)
Use:	cotton, all or unspecified	18.9
Product name and form:		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%	
Half-life (days):	8.4	
Are you assessing applications with variable rates or intervals?	yes	

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
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30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	Optional Test Species Name
Mammalian			
Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	Reference (MRID)
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

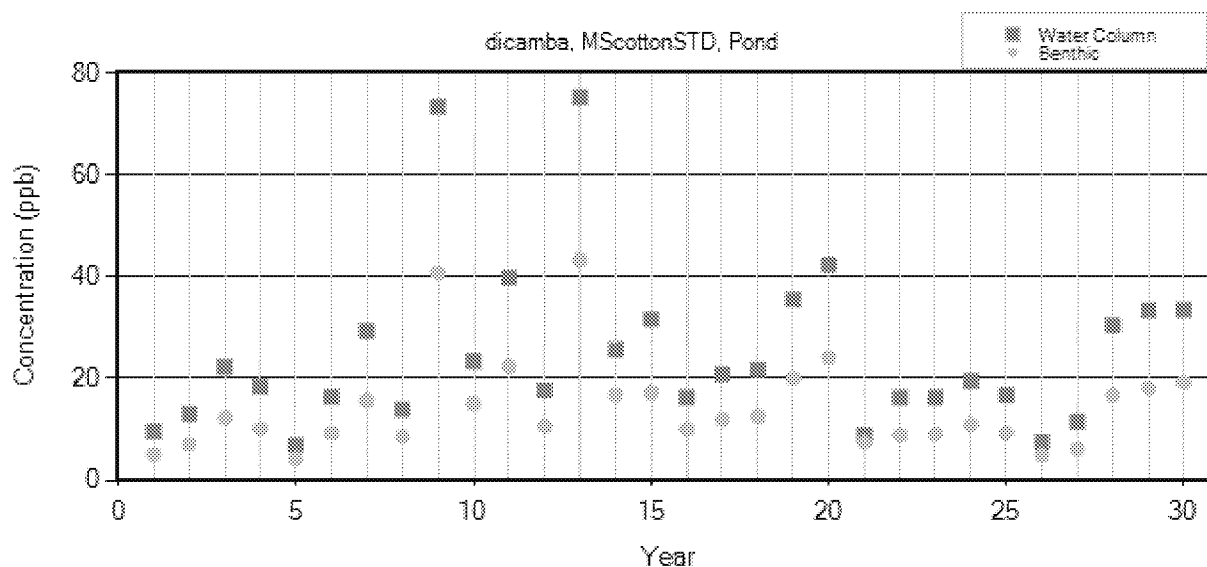


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 435792

MEMORANDUM

DATE: November 3, 2016

SUBJECT: M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide, EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Nathan Miller, Biologist
Michael Wagman, Biologist
Gabe Rothman, Environmental Scientist
William P. Eckel, Ph.D., Senior Science Advisor
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

NATHAN
MILLER

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ou=USEPA, ou=Staff, cn=NATHAN
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ou=Staff, cn=GABRIEL ROTHMAN,
dnQualifier=0000034717
Date: 2016.11.03 14:18:36 -0400

William P. Eckel

11/03/2016

THRU: Mark Corbin, Branch Chief
Monica Wait, RAPL
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

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Monica Wait

The Environmental Fate and Effects Division's March 2011 risk assessment for the proposed new use of dicamba diglycolamine (DGA) on dicamba-tolerant soybean discussed the potential for adverse effects on non-target plants due to spray drift and identified volatility (*i.e.*, vapor drift) as an uncertainty requiring additional evaluation (USEPA 2011).

In 2014, EFED issued an addendum to the 2011 risk assessment that looked more closely at the risk to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift using additional information submitted by Monsanto Company (USEPA 2014). The 2014 addendum acknowledged that volatility had been associated with dicamba historically, but did not quantitatively assess the risk for the new use on dicamba-tolerant soybeans, and

acknowledged that it was an uncertainty in the assessment. Based on the weight of evidence analysis, it was concluded that the dominant route of off-field exposure to non-target terrestrial and aquatic organisms was more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. The 2014 addendum concluded that without product- and nozzle-specific drift curves based on empirical data, the off-field distance that effects are expected for terrestrial plants remained uncertain. The addendum also noted that the uncertainties associated with estimated dicamba vapor concentrations in air and estimated deposition on plants would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity study measuring both toxic response and air exposure concentrations.

In March 2016, EFED issued a second addendum to the 2011 risk assessment that incorporated new field trial data (based on applications conducted in accordance with the draft label requirements {*e.g.* nozzles, spray pressures, ground speeds} designed to reduce spray drift), data from plant damage incidents, laboratory volatility data, and terrestrial plant reproductive effects data, all in relation to spray drift and volatilization (USEPA 2016a). Also in March 2016, EFED finalized a Section 3 new use risk assessment for use of dicamba DGA on dicamba-tolerant cotton (USEPA 2016b).

The March 2016 addendum and risk assessment concluded that based on the available data, a volatilization buffer equal to the spray drift buffer, extending 110 feet (for the 0.5 lb ae/A application rate) in all directions from the treated field, was justified. Among the available data, one open literature study (Egan and Mortensen 2012) directly addressed the potential for volatilization and transport of dicamba and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A dicamba DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. Egan and Mortensen estimated the 95% upper bound vapor exposure would drop below the soybean no-observed-adverse-effect-concentration (NOAEC) at a distance of approximately 25 meters (82 feet). This is well within the 110-foot downwind-only spray drift buffer proposed for the 0.5 lb/A rate. Thus, the March 2016 addendum and risk assessment concluded that the 110-foot buffer distance should be adequately protective of EPA's apical endpoints of plant height and yield following potential volatilization exposure.

Two product formulations of dicamba are discussed below. M-1691, a diglycolamine (DGA) salt of dicamba, is less volatile than older dicamba formulations such as dimethylamine (DMA) salts. (Dicamba DMA salts were not considered for use on genetically engineered soybeans or cotton). M-1768, or VaporGrip™, also a DGA salt, is formulated to be even less volatile than M-1691.

Recent data submissions, including field volatility (flux) studies of both M-1691 and M-1768 in Georgia and Texas, laboratory vapor-phase toxicity studies, and laboratory vapor-phase exposure (humidome) studies, provide evidence that decrease concerns and address earlier uncertainty about off-site vapor-phase exposure. The fair weather conditions (characterized by high temperatures in the low 90⁰s F during the day and a strong diurnal cycle of heating and cooling, humidity, and mixing conditions) throughout the study periods for both TX and GA made for near-idealized conditions for volatilization occurring after applications. These data indicate that

off-site volatility exposures will be less than the terrestrial plant level of concern (LOC) for listed plants (the NOAEC) for the M-1768 formulation, and will be between the NOAEC and the lowest-observed-adverse-effect-concentration (LOAEC) for M-1691. The margin between the expected exposure for M-1691 and the LOAEC is about ten-fold.

Based on the data described in the Appendix below, including the registrants' field studies and volatilization modeling, the 110-foot omnidirectional buffer for volatilization is no longer warranted for the M-1768 formulation, because the expected exposure at field's edge is less than the NOAEC. A buffer for the M-1691 formulation is also not warranted, taking the uncertainty of exposure and toxicity estimates into account, because the exposure is ten-fold less than the lowest effect level (LOAEC) at the edge of the field.

However, EFED finds that the in-field spray drift buffer of 110 feet downwind (0.5 lb/A rate) or 220 feet (1.0 lb/A) at the time of application must be maintained, because spray drift remains the main concern for potential off-site exposure.

As with all risk assessments, conclusions are made within the bounds of the stated uncertainties. In this case, these principally include whether the submitted field volatility studies adequately encompass the extremes of conditions that cause volatilization, and the statistical uncertainty in the calculation of the level of concern, which is based on the no-effect level for the most sensitive tested plant, soybean. It is possible that volatilization could be greater under conditions outside the scope of the submitted studies. Within these uncertainties, we conclude that no volatilization buffers are needed.

Results of the Georgia and Texas field volatility studies indicate that exposures from the M-1691 formulation are between the NOAEC and LOAEC for the most sensitive plant, while those from the M-1768 formulation are below the NOAEC. Thus, the M-1768 formulation is less likely to cause off-field effects from volatilization.

In August 2016, EPA's Office of Enforcement and Compliance Assurance issued a Compliance Advisory entitled "High number of complaints related to alleged misuse of dicamba raises concerns" (USEPA, 2016c). This document noted that 117 plant damage incidents affecting 42,000 acres have been reported to the Missouri Department of Agriculture (MDA) in the summer of 2016 due to alleged illegal "over-the-top" (post-emergent) use of currently registered dicamba products on dicamba-resistant cotton and soybeans and noted that similar reports have been received by Alabama, Arkansas, Illinois, Kentucky, Minnesota, Mississippi, North Carolina, Tennessee and Texas. These alleged applications would have been inconsistent with the label approved at that time because the over-the-top use had not yet been registered by EPA. Since the over-the-top use has not yet been approved, the labels on these products would not have had the restrictions on the current draft label (*e.g.*, specifying extremely-coarse or ultra-coarse nozzles, spray pressures, equipment speeds and the use of a 110 foot in-field buffer) designed to reduce spray drift. It is not clear at this time what caused these incidents. It is also not clear how the reported damage relates to the apical endpoints (plant height and weight) that are the basis of EPA's risk assessment. As more information becomes available on these and any other incidents, EPA will evaluate the incidents.

If registration of M-1691 and/or M-1768 is granted, EFED recommends analysis of any post-registration incident reports associated with their usage to confirm the findings in this analysis concerning the volatilization route of exposure. Comprehensive post-registration documentation of any incidents should include: wind and other weather conditions surrounding the associated application, whether label language designed to reduce spray drift was followed, and the distance between the application and the location with plant damage.

EFED's March 2016 addendum discussed previous incidents (2012-2015) that had been associated with dicamba use on dicamba-tolerant crops and noted that the Missouri Department of Agriculture had concluded that one incident was a result of volatilization of dicamba, rather than spray drift. EFED also noted in the March 2016 addendum that the incident observations were qualitative measures of visual injury (*e.g.* leaf spotting or curling), rather than quantitative estimates of damage (*i.e.* directly relating to EPA's apical endpoints of plant height, biomass and survival). Submission of field data that quantitatively link visual estimates of plant damage from dicamba to EPA's apical endpoints would be helpful for understanding the nature of the reported incidents and better incorporating any such data into future risk characterization of dicamba's potential effects due to potential volatilization.

Appendix. EFED Summary Conclusions on Vapor-Phase Toxicity of Dicamba and M-1691 and M-1768 Field Volatility (Flux) Studies and Deposition Analysis

Dicamba Vapor Phase (Humidome) Study Conclusions

A dicamba vapor toxicity response laboratory study was conducted and submitted by Monsanto Company to EPA in 2016 (Gavlick, 2016; MRID 49925703, supplemental suitable for quantitative use). The goal of this dose-response study was to identify a no-effect dicamba air exposure concentration for non-dicamba-tolerant soybean plants. Analytical and biological results were obtained. The analytical results explain that, percent acid equivalency dicamba applied being equal, the DGA form of applied dicamba is less volatile than the other dicamba formulations (*i.e.*, dicamba DMA and dicamba acid) as indicated by the amount of dicamba extracted from the polyurethane foam filter compared to the other formulations. The biological results indicate that soybean height (the only apical endpoint measured) is not significantly reduced compared to control plants following 24 hours of exposure (at 85°F for 16 hours and 70°F for 8 hours with 40% relative humidity) to vapor-phase dicamba at concentrations less than or equal to 0.0177 $\mu\text{g}/\text{m}^3$; however, 24 hour exposure (at 85°F for 16 hours and 70°F for 8 hours with 40% relative humidity) to concentrations of vapor-phase dicamba greater than or equal to 0.539 $\mu\text{g}/\text{m}^3$ significantly reduced soybean height compared to control plants (~32% reduction at the LOAEC of 0.539 $\mu\text{g}/\text{m}^3$). It is notable that the dose spacing in this study results in an approximately 30x difference between the NOAEC and LOAEC, creating uncertainty as to where effects to plants from vapor-phase exposure to dicamba may occur. Generally, definitive toxicity studies are conducted with lower dose-spacing (*e.g.* 1.5-3x geometric spacing between doses). Additional data examining a range of doses between the NOAEC and LOAEC from this study would reduce the uncertainty.

A separate humidome study was conducted by Monsanto Company to compare the volatility differences among dicamba DMA, dicamba DGA, and dicamba DGA plus VaporGrip™ (MRID 49770303). Nominally, 14.48 mg of dicamba acid was applied to 200 in² of bare soil in replicate humidomes (three humidomes for dicamba DGA, four humidomes for dicamba DGA plus VaporGrip™) which approximates the maximum single application rate of 1 pound dicamba a.e. per acre. For dicamba DGA applied alone, the study showed 0.0008% of the amount of dicamba applied volatilized off the soil, based on filter recoveries. The vapor-phase concentrations were determined to be 0.0407 $\mu\text{g}/\text{m}^3$, in line with upper bound concentration predicted by PERFUM from the flux data described in the field volatility study summaries (see next section titled: *Field Volatility (Flux) Studies and Deposition Estimates*), above the vapor-phase NOAEC, but below the vapor-phase LOAEC as determined in MRID 49925703. For dicamba DGA plus VaporGrip™, the study showed 0.00006% of the amount of dicamba applied volatilized off the soil, based on filter recoveries. The vapor-phase concentration was determined to be 0.00298 $\mu\text{g}/\text{m}^3$, which is below the vapor-phase NOAEC determined in MRID 49925703.

Field Volatility (Flux) Studies and Deposition Estimates

Field volatility research on the dicamba DGA salt formulation (M-1691) and dicamba DGA plus VaporGrip™ additive (M-1768) was conducted by Monsanto Company on treated fields in Georgia and Texas in 2015/2016 and submitted to EPA (Jacobson 2016a-d, respectively MRIDs 49888401, 49888403, 49888501 & 49888503). The fair weather conditions (characterized by high temperatures in the low 90⁰s F during the day and a strong diurnal cycle of heating and cooling, humidity, and mixing conditions) throughout the study periods for both TX and GA made for near-idealized conditions for volatilization occurring after applications. The flux data were incorporated into the EPA recommended AERMOD dispersion model¹ to estimate dicamba acid-equivalent (a.e.) deposition downwind from the treated field. Furthermore, the PERFUM model,² which is a post-processor for EPA recommended dispersion models, was used to provide estimated peak air concentrations for dicamba. Findings and deficiencies noted during review of these two studies and submitted deposition modeling by the registrant are discussed in greater detail below.

Upper-bound deposition and peak air concentrations predicted by AERMOD and PERFUM, respectively, from the flux data in these studies resulted with the M-1691 formulation. As a conservative estimate of vapor drift, the combined 90th upper-bound percentile predicted deposition (*i.e.* upper-bound predicted dry plus upper-bound predicted wet deposition) at 5-meters from the edge of field would be 3.12×10^{-5} lb a.e./A for the M-1691 formulation in Georgia, and the predicted peak air concentration is 6.03×10^{-2} µg/m³. Deposition estimates are generally an order of magnitude lower than the most sensitive vegetative vigor NOAEC, 2.61×10^{-4} lb a.e./A for soybean height from the available vegetative vigor data for terrestrial plants. The peak air concentration estimates, however, are above the NOAEC from the vapor-phase study discussed above (0.0177 µg/m³), but well below the LOAEC of 0.539 µg/m³ for soybean height. The upper-bound predicted combined deposition at 5-meters from the edge of field was ~ 50-60% lower for the M-1768 formulation (1.29×10^{-5} and 8.95×10^{-6} lb a.e./A deposition values or 2.08×10^{-2} and 8.80×10^{-3} µg/m³ peak air concentration values, respectively, in Georgia and Texas) compared to the M-1691 applications.

Based on the results from the deposition and air concentration analyses and considering the degree of uncertainty with these analyses (discussed in detail in the deficiencies section below), vapor drift occurring due to volatilization appears unlikely to be a concern for impacts off the treated field. Although the predicted peak air concentration for the M-1691 formulation exceeds the soybean vapor-phase exposure toxicity study NOAEC, it is well below the study's LOAEC. Additionally, the predicted upper bound peak air concentration values for the M-1768 formulation are essentially at or below the soybean vapor-phase NOAEC. Therefore, it is expected that the unidirectional spray drift buffer currently on labels mitigates deposition of dicamba material off the treated field.

The uncertainties associated with the flux data and deposition analysis, especially for the flux data from Texas, could result in underestimates of vapor drift under conditions more conducive

¹ Available on-line: https://www3.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod

² Available on-line: <http://www.exponent.com/experience/probabilistic-exposure-and-risk-model-for-fumigants/?pageSize=NaN&pageNum=0&loadAllByPageSize=true>

to codistillation than were tested in these studies. These are fully described below but include a) the lack of off-field sample data from the TX studies to determine volatilization flux during the application, b) volatilization flux during the applications measured at the GA site was not considered in the flux profile constructed for the modeling inputs and, and therefore not accounted for in modeling inputs, c) the time duration for deposition values are not specified in the study report and confounds the comparison of accumulated deposition with respect to toxicological endpoints, and d) applications timings occurred later in the day and missing the morning transition window of what would include the greatest differences in relative humidity and heating with conditions vulnerable to codistillation (this is particularly true for both M-1691 and M-1768 TX applications and the GA application with M-1691). However, the amount of uncertainty in the exposure estimates is small enough that it is very unlikely that the exposure will exceed the effect threshold (NOAEC). Refer to the fifth discussion point within the Deficiencies section below for further detailed information.

These uncertainties could be addressed through submission of the additional off-field sample data from TX, additional research on applications conducted during the morning weather transition window described above, and measured flux at the time of application with its incorporation into the deposition modeling analysis. Furthermore, the time duration for accumulation of deposition should be clarified to enable a more definitive comparison of exposure from vapor drift to available toxicological endpoints. Additionally, where incidents occur (that could be a result of either exposure to spray drift or volatilization), submission of information regarding the climatic conditions (temperature, relative humidity, wind speed and direction) both under which the suspect application occurred and following the application would assist with understanding the conditions under which volatilization exposure can occur. Additional incident data that would be informative includes quantitative measurements of damage comparable to EPA's apical endpoints (*i.e.* plant height, biomass, yield, etc.)

Findings As Gathered From Field Volatility (Flux) Studies (MRIDs 49888401, 49888403, 49888501, 49888503) and Results from AERMOD Deposition Modeling (MRIDs 49925701 – 02)

1. **Applications During Flux Studies** - The applications encompassing the M-1691 and M-1768 formulations were less than one kilometer apart in GA (pre-emergent app.) and several kilometers apart in TX (post emergent/foliar app. to cotton crop) and applications for both formulations occurring within 1 -2 hours of each other at each site.
2. **Weather Conditions After Applications During Flux Studies** - The fair weather conditions throughout the study periods for both TX and GA lend themselves to near-idealized conditions for volatilization occurring after applications. First, afternoons throughout all studies at both sites were very warm with maximum temperatures in the low 90's F. Furthermore, conditions for codistillation appear to be ideal with the weather as there is a strong diurnal cycle between the stable nocturnal regime (characterized by high relative humidity, relatively cool temps., and stagnant conditions) and convective daytime regime (characterized by relatively hot, low relative humidity, and more mixed conditions) at both sites after the applications.

3. **Flux/Concentration Magnitudes Observed in Flux Studies** - Very small concentrations (on the order of $<0.06 \mu\text{g}/\text{m}^3$) and resulting fluxes (on the order of $<0.0081 \mu\text{g}/\text{m}^2\text{-sec}$) found throughout the studies appear to be well supported by good recoveries from the Polyurethane Foam (PUF) analytical method evaluation and field spikes.
4. **Flux Events Observed in Flux Studies** - In most instances over both TX and GA, the highest levels of flux occurred at the time of application which occurred throughout the morning to early afternoon. Furthermore, there appears to be a strong diurnal signal with the timings of subsequent peak flux events. These subsequent events may be dependent on both the maximum heating of the day and/or the transitional periods between morning (relatively cool, high relative humidity, stagnant conditions) and afternoon (hot, low relative humidity, more mixing conditions). In most cases, peak flux events occurred between the hours of 7 – 20 after the application.
5. **Summary of AERMOD Deposition Modeling Estimates:**
Upper-bound estimates of deposition indicate reduced deposition and air concentrations following the M-1768 formulation applications as compared to the M-1691 formulation. **Table 1** shows the AERMOD and PERFUM estimates of the upper bound 90th percentile deposition and concentration, respectively, 5-meters from edge of field:

Table 1. AERMOD estimates of the upper 90th percentile 5-meters from edge of field

Deposition and Air Conc. Model Runs**	Study Site Flux Basis	AERMOD Dry Deposition* (lbs. dicamba a.e./A)	AERMOD Wet Deposition* (lbs. dicamba a.e./A)	AERMOD Upper-Bound Combined (Dry + Wet) Deposition (lbs. dicamba a.e./A)	PERFUM Upper-Bound Peak Air Conc. *,*** (μg/m ³)
Dicamba DGA Formulation (M-1691)					
1-3	Georgia	$2.08 \times 10^{-5} - 3.10 \times 10^{-5}$	$2.60 \times 10^{-8} - 2.34 \times 10^{-7}$	3.12×10^{-5}	6.03×10^{-2}
4-6	Texas	$9.99 \times 10^{-6} - 1.89 \times 10^{-5}$	$4.92 \times 10^{-8} - 1.78 \times 10^{-7}$	1.91×10^{-5}	2.48×10^{-2}
Dicamba DGA VaporGrip Formulation (M-1768)					
7-9	Georgia	$8.52 \times 10^{-6} - 1.28 \times 10^{-5}$	$2.03 \times 10^{-8} - 1.14 \times 10^{-7}$	1.29×10^{-5}	2.08×10^{-2}
10-12	Texas	$5.15 \times 10^{-6} - 8.86 \times 10^{-6}$	$2.43 \times 10^{-8} - 8.68 \times 10^{-8}$	8.95×10^{-6}	8.80×10^{-3}

Maximum values shown in **bold**.

*Range of upper 90th percentile estimates presented of AERMOD estimates from 3 model runs (see next note below).

**Three iterations of model runs encompass different weather conditions coupled with flux profiles input into AERMOD (deposition) or PERFUM (air concentrations). One year of weather data from Lubbock,

TX (surface) and Amarillo, TX (Upper Air); Peoria, IL (Surface) and Lincoln, IL (Upper Air); Raleigh, NC (Surface) and Greensboro, NC (Upper Air) used in analysis only during time of year with dicamba application windows. Phoenix, AZ weather data are also briefly cited but uncertain how that was used based on the study report alone.

***Peak estimated concentrations are one-hour concentrations.

Deficiencies with Field Volatility (Flux) Studies (MRIDs 49888401, 49888403, 49888501, 49888503) and AERMOD Deposition Modeling Analysis (MRIDs 49925701 – 02)

1. Air Sampling during Application with Flux Studies - Flux during the application was captured in the GA field volatility studies for both formulations using off-field samplers (indirect method). However, this was not done in any of the TX field volatility studies. While off-field samplers were included as part of the studies in TX, the data were discarded by the study authors briefly stating that samples possibly contained dicamba from other sources than volatilization. Submission of this discarded data would reduce some of the uncertainties discussed in this document.

2. Weather Conditions During Application with Flux Studies

The application timings for each flux study on each formulation is presented in the table below. As mentioned above, there are two weather phenomenon which may contribute to loss of dicamba via volatilization-related processes. The first is codistillation which may occur during the transition from high relative humidity (rh) conditions in the early morning to low relative humidity conditions in the late morning to early afternoon. The second is direct volatilization which may occur during the heating of the day.

The Georgia flux studies, particularly for the M-1691 formulation, may have only partially captured the impact of the transition from high rh to low rh conditions, and therefore losses could have been greater if applied earlier. Average relative humidities did fall from levels of 68 percent at 9 am to 51 percent at 10 am then to 34 percent at 11 am. However, rh was substantially higher earlier around 7 am with a maximum value of 94 percent observed. The M-1691 formulation was applied later in the morning, while the M-1768 formulation was applied more encompassing the morning transition (**Table 2**). Therefore, given that this transition may drive codistillation, comparisons in flux between the M-1691 and M-1768 may be confounded by the fact that the M-1768 formulation was possibly applied under potentially more vulnerable conditions for enhanced volatilization and resulting vapor drift.

For both Texas studies, both dicamba formulations occurred after the morning transition and into the more convective part of the day. While heating may have been a driver for volatilization, applications prior to the morning transition could have provided a more vulnerable set of conditions for loss of dicamba from the field.

Table 2. Dicamba formulation application timing and relative humidity

Formulation Applied	Application Timing	Average RH Range During Day of Study After Application Start	Maximum RH During Day of Study
Georgia Studies			
Dicamba DGA (M-1691)	9:54 am May 5, 2015	68 percent falling to 10 percent	94 percent 7 am
Dicamba DGA VaporGrip (M-1768)	8:05 am May 5, 2015	87 percent falling to 10 percent	
Texas Studies			
Dicamba DGA (M-1691)	11:10 am June 8, 2015	38 percent falling to 18 percent	96 percent 7 am
Dicamba DGA VaporGrip (M-1768)	1:15 pm June 8, 2015	23 percent falling to 18 percent	

- 3. Potential for Cross-Contamination Between M-1691 and M-1768 Plots During Flux Studies** To determine flux values ultimately used to estimate air concentrations and deposition, flux values need to be determined from a single field of application in order to arrive at an accurate amount of dicamba material that volatilizes and is ultimately driftable. This stated, it appears that the Georgia M-1691 and M-1768 application plots are very close to each other, within 500 meters of each other. In Texas, the two treated plots for each formulation are farther apart, about 5 kilometers from each other. In both cases, the plots with the M-1768 formulations could potentially have been influenced by dicamba material blowing downwind from the plots treated with the M-1691 formulations (**Figure 1**). Furthermore, the typical logarithmic decrease of concentrations with height for flux studies was not strong immediately after the application for the Texas M-1768 application, indicating that there may have been some confounding impacts from cross-contamination. However, this was also the case immediately after the application for the Texas M-1691 application which was applied before the M-1768 application. There were no such anomalies in the vertical concentration profile in the Georgia studies where the concentrations with height over the field exhibited the expected logarithmic decreasing trend.

While cross-contamination can theoretically exist with dicamba applications to multiple fields over a local area, the deposition analysis submitted by the registrant includes up to an 80-acre field treated with each dicamba formulation. This is a large area treated and the resulting exposure to plants off the treated field conveyed in the registrant's analysis would be expected to capture any potential impacts of cross-contamination that can occur accumulated from smaller fields. However, to reiterate, results from a discretely treated field is desired considering the purposes of a field volatility study described above.

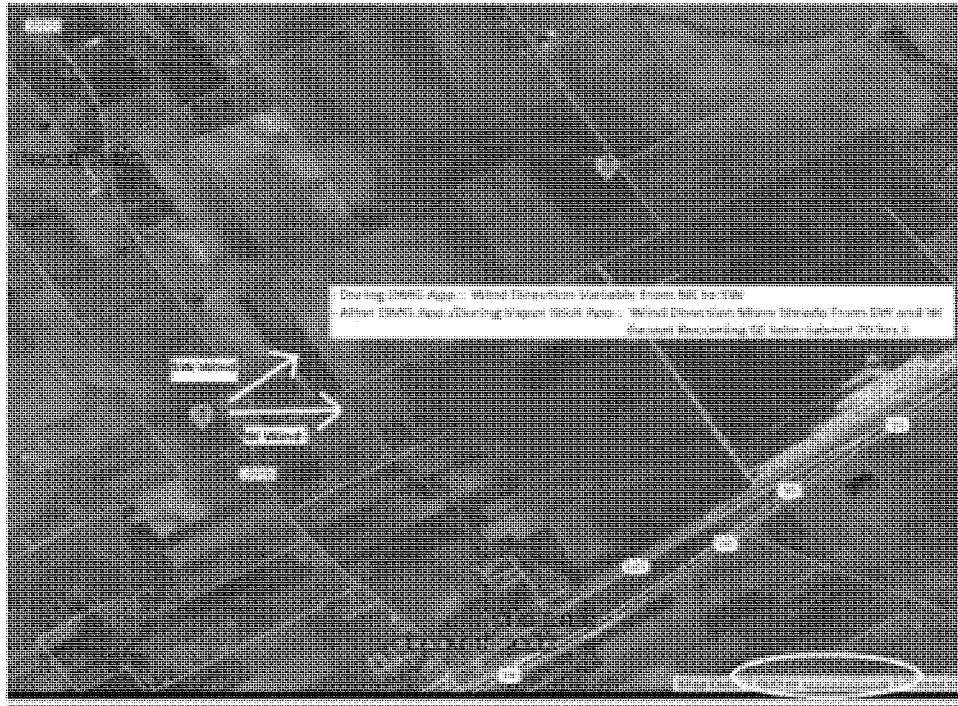
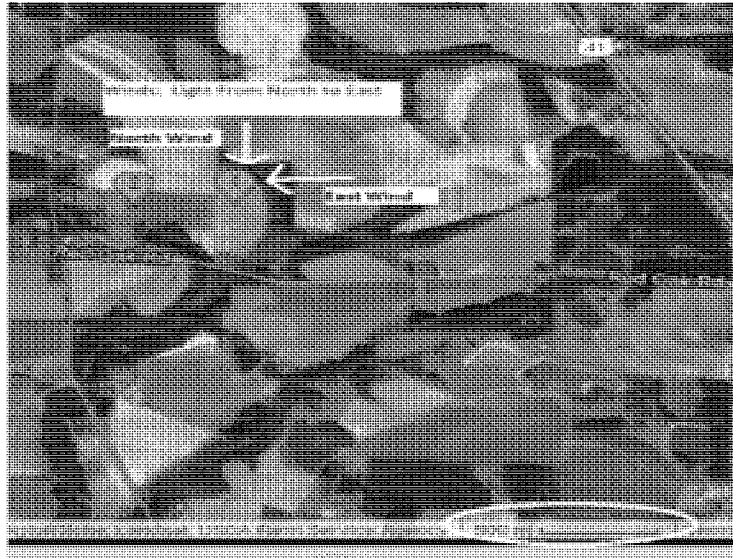


Figure 1. Map of GA field sites (top) and TX field sites (bottom). Site 1 delineates M-1691-only application. Site 2 delineates M-1768 application.

4. **Environmental Chemistry Methods and Method Validation Supporting Flux Studies** – Upon review, it appears that the field volatility study reports include an adequate evaluation of the polyurethane foam (PUF) sampling procedure employed in air samples for these studies. However, an independent laboratory validation demonstrating repeatable performance could not be found. A GLP compliance statement was submitted.
5. **Flux Modeling.** Flux during the application period was not modeled for either the GA or TX site. Flux was not reported for the application period in TX; the measured flux in GA was 1.6 to 1.7 times higher (M-1691 and M-1768, respectively) than in any later measurement period. Even if additional flux of this magnitude was included in the modeling exercise, the total exposure from volatilization would still be below the vapor-phase LOAEC and vegetative vigor NOAEC for M-1691. Modeled exposures would also be below vapor-phase and vegetative vigor endpoints for M-1768.
6. **Interpretation of AERMOD Deposition Values** – In all AERMOD deposition values provided by the registrant, the time durations of the deposition values (e.g., one-hour, four-hour, or 24-hour) is not specified. Since deposition reflects a cumulative value of mass accumulation over time, it becomes difficult to compare exposure impacts to toxicological impacts over a period of time if this information is not provided. However, for the PERFUM air concentration modeling analysis, the registrant did provide sufficient air concentration time averages (e.g., 1-hour, 4-hour, 8-hour, and 24-hour period averages) for appropriate comparisons to the toxicological endpoints.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

TO: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Daniel Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)

FROM: Michael Wagman, Biologist *EW* 3/24/16
Elizabeth Donovan, Biologist *ED* 3/24/16
William P. Eckel, Ph.D., Senior Science Advisor *WPE* (For BE) 3-24-16
Amy Blankinship, Senior Science Advisor *AB*
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II® XTENDFLEX™ cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bce)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Table 2: Dicamba ECR Proposed Use Pattern for Dicamba-Tolerant Cotton							
Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

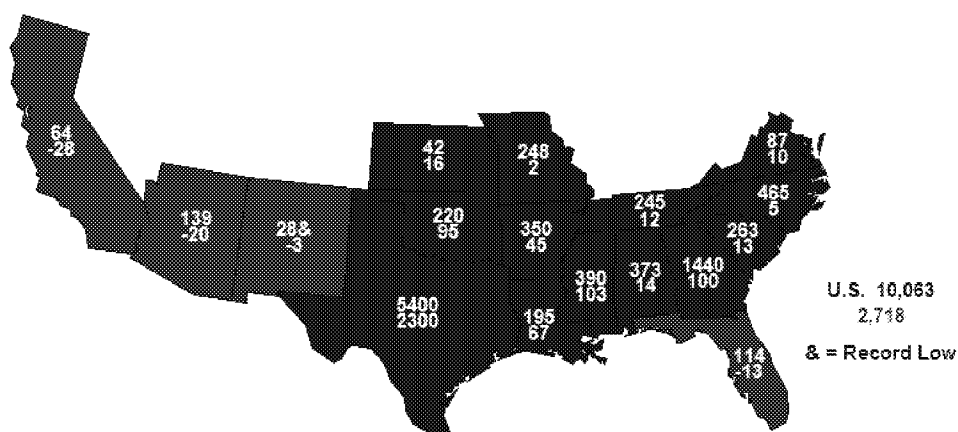
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3 and 4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _∞ (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and ***bold italicized*** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
	Arthropod	0.0143	4.19	17.58	0.24
Medium (35g)	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
	Arthropod	0.0231	2.90	14.23	0.20
Large (1000g)	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 ($>100/42 = >2.38$).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTI11004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, than given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	
Seed Treatment? (Check if yes)	<input type="checkbox"/>	Seeding Rate (lbs/acre)
Use:	cotton, all or unspecified	18.9
Product name and form:		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%	
Half-life (days):	8.4	
Are you assessing applications with variable rates or intervals?	yes	

Do NOT specify application day at Column F and % a.i. you may enter up to 30 applications

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
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19		
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28		
29		
30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	Optional Test Species Name
Mammalian			
Size (g) of mammal used in toxicity study		Acute Study	Chronic Study
Default rat body weight is 350 grams		350	350
Endpoint	Toxicity value	Reference (MRID)	
LD50 (mg/kg-bw)	2740.00		
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

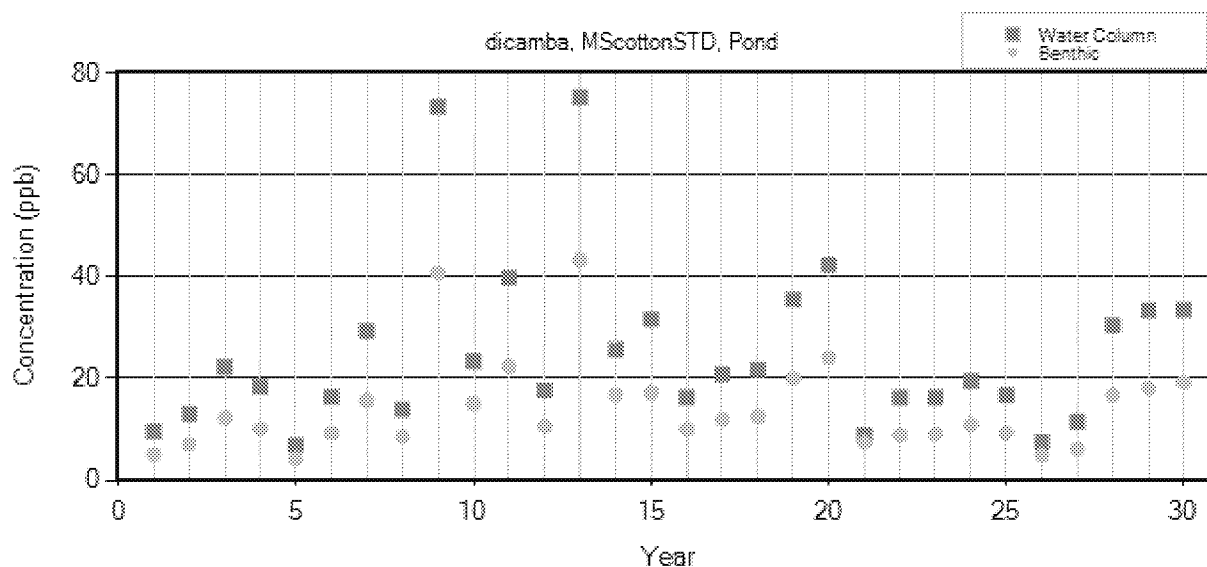


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

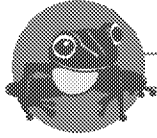
EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



September 12, 2016

Office of Pesticide Programs
Environmental Protection Agency Docket Center (EPA/DC)
EPA West Building, Room 3334
1301 Constitution Ave NW
Washington, DC 20460-0001

**Re: Comments on EPA Opening the Registration Review Docket – Dicamba
(Docket #: EPA-HQ-OPP-2016-0223)**

Please accept the following comments on behalf of the Center for Biological Diversity (“Center”) in response to the Environmental Protection Agency’s (“EPA”) opening the registration review docket for dicamba under the Federal Insecticide, Fungicide, and Rodenticide Act (“FIFRA”). The Center previously submitted comments on a new use of dicamba on herbicide-tolerant cotton and soybean (Docket #: EPA-HQ-OPP-2016-0187) and incorporates those comments by reference.

The Center for Biological Diversity (“Center”) is a non-profit environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has more than one million members and online activists dedicated to the protection and restoration of endangered species and wild places. The Center has worked for twenty-six years to protect imperiled plants and wildlife, open space, air and water quality, and overall quality of life. The Center’s Environmental Health Program aims to secure programmatic changes in the pesticide registration process and to stop toxic pesticides from contaminating fish and wildlife habitats. We appreciate the opportunity to provide comment.

Before the EPA can make a supportable decision to authorize additional uses of this pesticide, it must first accomplish all of the following:

1. Comply with duties under Section 7 of the Endangered Species Act (ESA),¹ including completion of consultation.

As a separate, discretionary action that may affect endangered and threatened species, the EPA cannot approve new uses prior to the completion of consultations with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (“the Services”). Without such consultation, the EPA cannot satisfy its duty to insure that its action does not jeopardize the continued existence of imperiled species across the country or adversely modify or destroy their critical habitat. Moreover, unless and until the EPA completes ESA consultation, any taking of protected species from the use of this pesticide is unlawful.

Section 7(a)(2) of the Endangered Species Act (“ESA”) requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary . . . to be critical.”² Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.³ Indeed, the EPA’s recently finalized policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.⁴ The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.⁵ The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character, triggers the formal consultation requirement.”⁶ Accordingly, the EPA must consult with the Services on its continuing and ongoing authority over this pesticide to satisfy its duty to insure that its use will not jeopardize or adversely modify protected species or their critical habitat well *before* it proposes a registration review decision. *See* Endangered Species Act Consultation Obligations for Pesticide Approvals by the Environmental Protection Agency (enclosed).

The EPA must consult on all synergistic and cumulative uses. The EPA must insure that all uses of this pesticide do not jeopardize species protected by the ESA or adversely modify or destroy their critical habitat, including uses with other ingredients or other pesticides. Absent

¹ 16 U.S.C. § 1536.

² 16 U.S.C. § 1536(a)(2) (emphasis added).

³ 50 C.F.R. § 402.14(a).

⁴ http://www.epa.gov/oppfead1/cb/csb_page/updates/2013/esa-regreview.html

⁵ 50 C.F.R. § 402.14(a).

⁶ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

information or data to determine whether dicamba will act synergistically with other ingredients, such uncertainty requires that the EPA decline to re-register any end use products containing more than one active ingredient and prohibit tank mixing on the labels.

At a minimum, where a product may affect listed species, all product labels must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁷

2. Require that that the registrant provide all necessary data and studies.

The EPA must have substantial evidence to re-register this pesticide. To do so, the EPA must require all necessary data and studies, including, but not limited to any previously identified data or study gaps, additional studies to evaluate effects on pollinators in accordance with the *Guidance for Assessing Pesticide Risks to Bees*,⁸ information concerning estrogen or other endocrine disruption effects,⁹ and any information that this pesticide or products containing this pesticide may have synergistic effects.

3. Incorporate necessary factors into evaluation and any proposed decision.

These factors should include the following, at a minimum:

- a. effects on species listed as protected under the ESA and their critical habitat,
- b. effects on pollinators and other beneficial insects,
- c. effects on human health or environmental safety concerning endocrine disruption, and
- d. any additive, cumulative or synergistic effects of the use of this pesticide.

⁷ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

⁸ EPA 2014. *Guidance for Assessing Pesticide Risks to Bees*. Available at https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf

⁹ See 21 U.S.C. §§ 346a(d)(2)(A)(x) and 346a(p).

EPA cannot propose a registration review decision under FIFRA (often described as “interim”) and satisfy its legal duties unless it requires sufficient information and evaluates it for adverse effects before reaching any conclusions.

Congress tasked the EPA with regulation of pesticides for safe use. FIFRA authorizes EPA to register a pesticide only upon determining that the pesticide “will perform its intended function without unreasonable adverse effects on the environment,” and that “when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse effects on the environment.”¹⁰ The statute defines “unreasonable adverse effects on the environment” to include “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.”¹¹ The EPA cannot meet this standard without requiring, evaluating and considering all information that causes adverse effects from the additional use of this pesticide. *Pollinator Stewardship Council v. U.S. E.P.A.*, Case No. 13-72346, Dkt. No. 58-1 at 6, 2015 WL 5255016, *1.

4. Place appropriate restrictions on uses to avoid and minimize adverse effects.

The EPA has broad authority to restrict uses and place strong mitigation language on labels to avoid adverse effects and when there is uncertainty.

5. The EPA Needs to Take Into Account Real-world Scenarios.

The EPA often claims that it is acting conservatively by using the maximum labeled use rates when estimating exposure to plants and animals. These upper-level exposure scenarios, however, do not take into account accidental spills and illegal uses of the pesticide.

A recent survey of farmers in Missouri indicated that less than half -- only 43 percent -- actually read the label each time they use pesticides.¹² Sixteen percent only read the label half the time or less and 1.2 percent have never read the label at all. Pesticide labels also have wind speed requirements that are meant to reduce drift and are used in EPA’s risk assessment process to estimate off-site exposure. Four percent of pesticide applicators never checked the wind speed before application and 40 percent of applicators checked wind speed by looking at trees, a very unreliable form of measurement that is often inaccurate.

Therefore, the ever-present possibility of an accidental spill indicates that this is a reasonably foreseeable event that should be accounted for when estimating peak exposure concentrations. In

¹⁰ 7 U.S.C. § 136a(e)(5)(C), (D); 40 C.F.R. § 152.112(e).

¹¹ 7 U.S.C. § 136(bb).

¹² Randall. July 13th, 2016. State news. *57 percent of those applying pesticides in Missouri do not read label instructions*. Available at: <http://www.kttm.com/57-percent-of-those-applying-pesticides-in-missouri-do-not-read-label-instructions/>.

addition, the small amount of data that are available on label compliance indicate that it is unreasonable to assume that pesticides are always applied in accordance with the label. We feel that when communicating findings to a risk manager, the EPA no longer refer to its use of maximum labeled rates as “conservative” or accurately estimating peak exposures that may occur.

6. The EPA needs to take into account increased use of dicamba in its risk assessments.

The EPA’s risk assessment approach is not designed to analyze risk due to increased total usage of a pesticide compared to current levels. It is simply designed to estimate exposure to a single chemical based on labeled usage rates on specific crops. This exposes one of the great shortcomings in EPA’s risk assessment approach – it is very short sighted. It takes a narrow approach of assessing risk without taking into account the bigger picture of total usage of a particular pesticide or combined usage of multiple pesticides. Therefore, risk is typically underestimated and potential increases in total pesticide usage are not accurately assessed for potential harms.

The EPA recognized this when proposing to register dicamba for use on dicamba-resistant cotton and soy and stated that “[a]lthough the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications.”¹³ And, “[t]hough the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans.”¹⁴

Dicamba use is on the rise and if the EPA approves the “new use” of dicamba on dicamba-tolerant cotton and soybeans it will result in an even greater increase.^{15,16} Monsanto did an

¹³ EPA. Memorandum. Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). Docket ID: EPA-HQ-OPP-2016-0187-0008.

¹⁴ EPA. Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean. Docket ID EPA-HQ-OPP-2016-0187-0016.

¹⁵ EPA. Memorandum. Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 8770 I). Docket ID EPA-HQ-OPP-2016-0187-0005. Page 36.

¹⁶ Mortensen, DA, Egan, JF, Maxwell, BD, Ryan, MR, Smith, RG. Navigating a Critical Juncture for Sustainable Weed Management. *BioScience* (2012) 62 (1): 75-84. doi:10.1525/bio.2012.62.1.12. and Bohnenblust, EW, Vaudo,

analysis on the possible future increase in use of dicamba for USDA when applying for deregulation of genetically engineered (“GE”) dicamba/glyphosate resistant soybean and cotton. Monsanto predicted that annual commercial dicamba use on soybeans would increase from 233,000 pounds in 2011 to 20.5 million pounds at the time of peak (40%) GE crop adoption.¹⁷ This is a nearly 100-fold increase in dicamba usage just on soybean and could be even higher if these GE crops are more widely adopted. Similar projections were made for dicamba use on cotton from 364,000 pounds applied annually in 2011 to 5.2 million pounds at the time of peak (50%) adoption.¹⁸ Assuming peak adoption of dicamba resistant soybean and cotton would occur in the next 3-4 years, the U.S. is looking at a more than 25 million pound increase in dicamba usage for these two crops by 2020.

Although this is likely an underestimate, as crop adoption rates will likely be much higher and current labels actually urge users to spray higher than typical rates to slow weed resistance, it is a starting point for the EPA to begin to analyze the effects of total pesticide load on human and environmental health. This increase in dicamba usage would not likely displace other herbicide use. The EPA needs to view registration decisions as not only a way to analyze the effects of labeled pesticide usage, but also as a way to ensure that total pesticide use does not increase. The EPA could take this into account in the cost-benefit analysis by analyzing the associated costs of labeled pesticide use as well as the costs associated with total pesticide load in the environment.

There are many parallels here with what happened with glyphosate in the 1990’s. In 1993, the EPA re-registered glyphosate with the finding that labeled use of glyphosate would not cause unreasonable adverse effects on the environment. Of course, a couple of years later the widespread adoption of “Roundup Ready” GE crops resulted in an exponential increase in glyphosate use from around 10 million pounds to around 300 million pounds per year in 25 years.¹⁹ This resulted in many unforeseen environmental problems, most notably by playing a large role in the dramatic decline of the Monarch butterfly. The rapid rise in glyphosate has destroyed Monarch habitat across most of the Midwest and the Monarch is currently being considered for a “threatened” listing under the Endangered Species Act. Glyphosate’s affect on the Monarch was not even discussed in the 1993 ERA for glyphosate. But it happened. There are

AD, Egan, JF, Mortensen, DA, Tooker, JF. Effects of the herbicide dicamba on nontarget plants and pollinator visitation. *Environ Toxicol Chem.* (2016) 35(1): 144-51. doi: 10.1002/etc.3169.

¹⁷ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS appendix, Table 4-9 and page 4-16.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁸ USDA. *Monsanto Petitions (10-188-01p and 12-185-01p) for Determinations of Nonregulated Status for Dicamba Resistant Soybean and Cotton Varieties. Final environmental impact statement. EIS Appendix, Table 4-12 and page 4-19.* 2014; Available from: http://www.aphis.usda.gov/brs/aphisdocs/dicamba_feis_appendices.pdf.

¹⁹ USGS. *U.S. Geological Survey: Pesticide National Synthesis Project, pesticide use maps-glyphosate.* 2014. [Accessed on 09/12/2016]; Available from: https://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2014&map=GLYPHOSATE&hilo=L&disp=Glyphosate.

two reasons for this: 1) the glyphosate ERA did not analyze indirect effects, like those on the milkweed plant that the Monarch is completely reliant on and 2) the EPA did not analyze how such a quick increase in total glyphosate usage would affect the environment. In its dicamba analysis, the EPA needs to fix these two shortcomings in its ERA process and accurately analyze how the inevitable increase in dicamba load in the environment, in combination with glyphosate, will affect human health and the environment.

7. The EPA needs to assess the enhanced toxicity of pesticide mixtures.

The EPA has made no mention of whether it intends to finally do a robust mixture analysis in the upcoming registration review docket. It has long been the EPA's policy to not do a mixture analysis because it's just too darn hard. Yet there is never any mention that this decision essentially results in the default assumption that all mixtures involving dicamba have the exact same toxicity as dicamba alone, a completely scientifically-unjustified assumption. The EPA is constantly saying that there are never enough data and that they lack the methodology to do a robust analysis. But the agency completely ignores the fact that by approving so many multi-ingredient formulations and allowing countless numbers of tank mixtures to occur, it is essentially enabling the existence of all of these mixtures without any data whatsoever that it can be done safely. These are not the actions of an agency that is confident in its abilities to protect the health of humans and the environment; these are the actions of an agency that is in way over its head.

The Center for Biological Diversity recently released a report²⁰ analyzing an unconventional new source of much needed data – patent applications. When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant. For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

We conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta). Our key finding was that 69 percent of these products (96 out of 140) had at least one patent application

²⁰ Donley, N. (2016). Toxic Concoctions: How The EPA Ignores The Dangers Of Pesticide Cocktails. Retrieved from The Center for Biological Diversity website: http://www.biologicaldiversity.org/campaigns/pesticides_reduction/pdfs/Toxic_concoctions.pdf. Submitted to the docket with comment letter.

that claimed or demonstrated synergy between the active ingredients in the product.

There were 11 multi-ingredient products containing dicamba that were approved in the past six years from these four companies.²¹ Of those 11, ten have evidence of synergy between the active ingredients in the product. The identified patent applications in our report found synergistic toxicity to plants from the combinations of:

- 1) Dicamba and glyphosate (U.S. patent application numbers 13099552 and 13751021)
- 2) Dicamba and penoxsulam (U.S. patent application number 14026902)
- 3) Dicamba and Isoxaben/indaziflam (U.S. patent application numbers 13841457 and 12506456)

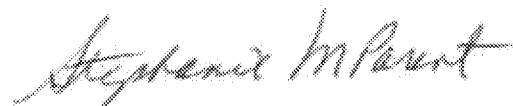
None of these patent applications were discussed in any documents in the docket despite being directly relevant to the analysis at hand. Since most products that contain dicamba were approved more than six years ago, our analysis would not have identified other patent applications or studies that may be relevant to other dicamba products.

This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them.

Therefore, in order to be compliant with FIFRA, the EPA must do an analysis of mixture toxicity with mixtures containing dicamba before a re-registration decision can be made.

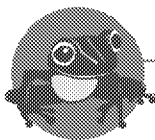
If the EPA does not think that it has the proper methodology in place to do this analysis, prohibiting the co-application of certain pesticides with dicamba through label changes and cancelling certain products that contain these mixtures is another way the EPA can ensure that any registration decision is compliant with FIFRA. Otherwise, the EPA will not be able to conclude that the continued use of dicamba will not have unreasonable adverse effects on the environment.

Respectfully submitted,



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²¹ *Id.* at Appendix B



ENDANGERED SPECIES ACT CONSULTATION OBLIGATIONS FOR PESTICIDE APPROVALS BY THE ENVIRONMENTAL PROTECTION AGENCY

I. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on Pesticide Approvals.

Section 7(a)(2) of the ESA requires that “each federal agency *shall*, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary... to be critical.”²² Under Section 7(a)(2), the EPA must consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service (collectively the “Services”) to determine whether its actions will jeopardize listed species’ survival or adversely modify designated critical habitat, and if so, to identify ways to modify the action to avoid that result.²³ The consultation requirement applies to any discretionary agency action that may affect listed species.²⁴ Because the EPA may decline to approve pesticides and uses, its decision represents a discretionary action that clearly falls within the ESA’s consultation requirement.²⁵

The EPA must initiate consultation under Section 7 whenever its action “may affect” a listed species or critical habitat.²⁶ Under the Services’ joint regulations implementing the ESA, the EPA is required to review its actions “at the earliest possible time” to determine whether the action may affect listed species or critical habitat.²⁷ Indeed, the EPA’s policy *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes* envisions informal consultations with the Services beginning at the preliminary risk assessment stage.²⁸ The Services define “may affect” as “the appropriate conclusion when a proposed action may pose *any* effects on listed species or designated critical habitat.”²⁹ This inquiry even includes beneficial effects. The phrase “may affect” has been interpreted broadly to mean that “any possible effect, whether beneficial, benign, adverse, or of an undetermined character,

²² 16 U.S.C. § 1536(a)(2) (emphasis added).

²³ 50 C.F.R. § 402.14.

²⁴ *National Association of Home Builders v. Defenders of Wildlife*, 551 U.S. 644 (2007).

²⁵ See *Washington Toxics Coalition v. EPA*, 413 F. 3d 1024, 1032 (9th Cir. 2005) (“even though EPA registers pesticides under FIFRA, it must also comply with the ESA when threatened or endangered species are affected.”).

²⁶ 50 C.F.R. § 402.14(a).

²⁷ 50 C.F.R. § 402.14(a).

²⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013) at p. 8

²⁹ U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998, *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act* (hereafter CONSULTATION HANDBOOK) at xvi (emphasis in original).

triggers the formal consultation requirement.”³⁰ For this initial stage of review, exposure to a pesticide does not require that effects reach a pre-set level of significance or intensity to trigger the need to consult (e.g. effects do not need to trigger population-level responses). As the Services’ joint consultation handbook explains, an action agency such as the EPA may make a “no effect” determination, and thus avoid undertaking informal or formal consultations, only when “the action agency determines its proposed action will not affect listed species or critical habitat.”³¹

Because the use of these pesticide formulations and products “may affect” listed species and “may affect” the critical habitat of listed species, the EPA must consult with the Services regarding its pesticide approvals in order to comply with the ESA.

Fortunately the National Academy of Sciences (“NAS”) has provided guidance regarding the obligations of EPA and other wildlife agencies in analyzing pesticide approvals under the ESA. The NAS committee provided a report to the EPA and Services in April of 2013 providing specific recommendations relating to the use of “best available data,” methods for evaluating sublethal, indirect, and cumulative effects; the state of the science regarding assessment of mixtures and pesticide inert ingredients; the development, application, and interpretation of results from predictive models; uncertainty factors; and what constitutes authoritative geospatial and temporal information for the assessment of individual species, habitat effects and probabilistic risk assessment methods.³²

While the NAS report outlines areas for all three agencies to improve, the NAS report made several significant conclusions about the current ecological risk assessment process and its use of risk quotients (“RQs”), including:

- The EPA “concentration-ratio approach” for its ecological risk assessments “is ad hoc (although commonly used) and has unpredictable performance outcomes.”³³
- “RQs are not scientifically defensible for assessing the risks to listed species posed by pesticides or indeed for any application in which the desire is to base a decision on the probabilities of various possible outcomes.”³⁴
- “The RQ approach does not estimate risk...but rather relies on there being a large margin between a point estimate that is derived to maximize a pesticide’s environmental concentration and a point estimate that is derived to minimize the concentration at which a specified adverse effect is not expected.”³⁵

³⁰ *Western Watersheds Project v. Kraayenbrink*, 632 F.3d 472, 496 (9th Cir. 2011) (brackets omitted) (quoting 51 Fed. Reg. at 19,949). The threshold for triggering ESA consultation “is relatively low.” *Lockyer v. U.S. Dep’t of Agric.*, 575 F.3d 999, 1018 (9th Cir. 2009).

³¹ CONSULTATION HANDBOOK at 3-13.

³² National Academy of Sciences 2013. *Assessing Risks to Endangered and Threatened Species from Pesticides* (hereafter NAS REPORT), Committee on Ecological Risk Assessment under FIFRA and ESA Board on Environmental Studies and Toxicology Division on Earth and Life Studies National Research Council (April 30, 2013).

³³ *Id.* at 107.

³⁴ *Id.* at 11.

³⁵ *Id.*

- “Adding uncertainty factors to RQs to account for lack of data (on formulation toxicity, synergy, additivity, or any other aspect) is unwarranted because there is no way to determine whether the assumptions that are used overestimate or underestimate the probability of adverse effects.”³⁶

According to the NAS, the EPA concentration-ratio approach contrasts sharply with a probabilistic approach to assessing risk, which the NAS describes as “technically sound.” The NAS’s underlying conclusion is that EPA should move towards a probabilistic approach based on population modeling, an approach that the NMFS already utilizes.³⁷ The NAS also recommends that the FWS move towards a probabilistic approach in its consultations.

Following the publication of the NAS report, the agencies have developed two policy documents to guide consultations on pesticide review and approvals moving forward: (1) *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes*,³⁸ and (2) *Interim Approaches for National-level Pesticide Endangered Species Act Assessments Based on Recommendations of the National Academy of Science April 2013*.³⁹ The agencies made clear at a November 15, 2013 public meeting that these new procedures and approaches would be “day forward” in their implementation.⁴⁰ Accordingly, approvals of pesticides and uses *must* follow these new *Interim Approaches* and comply with the requirements of the ESA.

A. Completion of Step One under Interim Approaches

As laid out in the National Academy of Sciences and *Interim Approaches* guidance, the risk assessment and consultation process should follow three steps.⁴¹ These steps generally follow the three inquiries of the ESA consultation process: (1) the “no effect”/ “may affect” determination (2) the “not likely to adversely affect”/ “likely to adversely affect” determination (3) the jeopardy/no jeopardy and adverse modification/no adverse modification of critical habitat determination. Step One generally follows the requirements of the ESA and will in most cases identify those species at risk from pesticides that need additional review through the informal and formal consultation process. At Step One, the EPA must gather sufficient data to complete the following two related inquiries: (1) the EPA must determine whether pesticide use areas will overlap with areas where listed species are present, including whether a use area overlaps with any listed species’ critical habitat (2) the EPA must determine whether off-site transport of pesticides will overlap with locations where listed species are present and/or critical habitat is designated. Off-site transport must include considerations of downstream transport due to runoff

³⁶ *Id.*

³⁷ *Id.* at 107.

³⁸ U.S. Environmental Protection Agency 2013, Office of Chemical Safety and Pollution Prevention- Office of Pesticide Programs, *Enhancing Stakeholder Input in the Pesticide Registration Review and ESA Consultation Processes and Development of Economically and Technologically Feasible Reasonable and Prudent Alternatives*, Docket ID #: EPA-HQ-OPP-2012-0442-0038 (March 19, 2013).

³⁹ Available at <https://www.epa.gov/sites/production/files/2015-07/documents/interagency.pdf>

⁴⁰ INTERAGENCY APPROACH FOR IMPLEMENTATION OF NATIONAL ACADEMY OF SCIENCES REPORT: ASSESSING RISKS TO ENDANGERED AND THREATENED SPECIES FROM PESTICIDES, Public Meeting Silver Spring NOAA Auditorium (Nov. 15, 2013).

⁴¹ NAS REPORT at 37-38.

as well as downwind transport due to spray drift when the best available science indicates such transport is occurring.⁴²

What the EPA should do to meet the legal requirements of the ESA is use the best available spatial data regarding the pesticide use patterns and the distribution and range of listed species to determine whether a pesticide's use overlaps with species, and then make a "may affect"/"no effect" determination. The Fish and Wildlife Service ECOS website provides GIS-based data layers for each listed species with designated critical habitat.⁴³ These maps are scalable and can achieve the precision needed to make accurate effects determinations regarding whether a pesticide will have "no effect" or "may affect" a listed species and are certainly accurate enough to make determinations as to whether the use of a pesticide represents adverse modification of critical habitat. Figure One provides an overlay map from ECOS of all critical habitat that has been designated for listed species thus far.

Other sources provide additional data on the distribution and life history of threatened and endangered species. NatureServe provides detailed life history information, including spatial distribution, for native species across the United States.⁴⁴ In addition, many State governments collect detailed information on non-game species through their State Wildlife Action Plans.⁴⁵ In short, there are many sources of data that can provide EPA with the detailed information it needs to conduct an effects determination for each species. If there is a subset of species where it believes information is still lacking, EPA should make that clear to all stakeholders which species specifically it believes such data are lacking early in the process such that this information can be collected from the Services and other sources.

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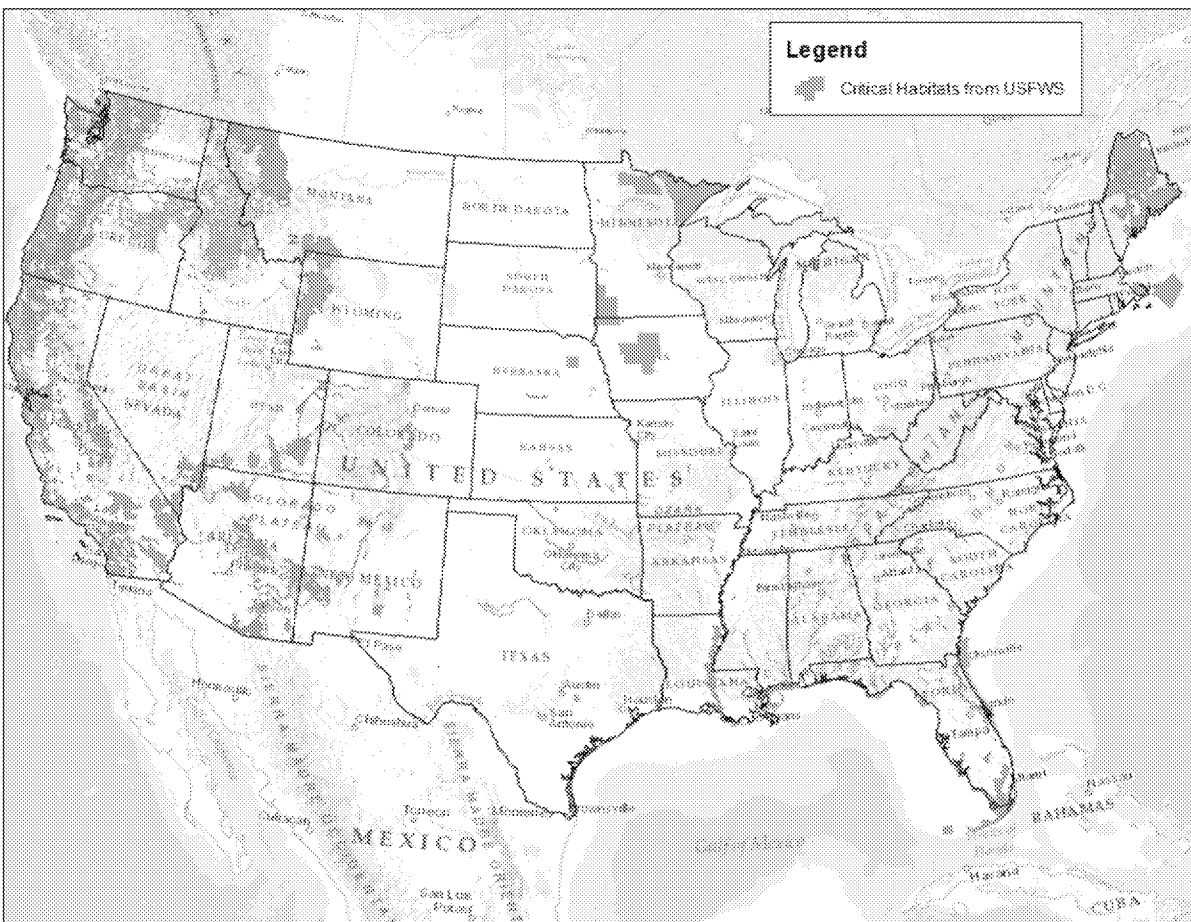
⁴² The Center acknowledges that in many areas, atmospheric transport is difficult to model and assess. However, in some areas, the impacts of atmospheric transport of pesticides are well understood. A recent study found that a variety of pesticides are accumulating in the Pacific chorus frogs (*Pseudacris regilla*) through atmospheric deposition at remote, high-elevation locations in the Sierra Nevada mountains, including in Giant Sequoia National Monument, Lassen Volcanic National Park, and Yosemite National Park Smalling, K.L., et al. 2013. *Accumulation of Pesticides in Pacific Chorus Frogs (Pseudacris regilla) from California's Sierra Nevada Mountains*, Environmental Toxicology and Chemistry, 32:2026–2034.

⁴³ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁴ NatureServe Get data. <http://www.natureserve.org/getData/index.jsp>

⁴⁵ State Wildlife Action Plans. <http://teaming.com/state-wildlife-action-plans-swaps>

Figure One – Base Composite Map of Critical Habitat in the United States⁴⁶



To make scientifically valid effects determinations, EPA will also need the best available spatial data regarding the use of pesticides. The U.S. Department of Agriculture and the U.S. Geological Survey⁴⁷ collect data on an enormous suite of pesticide active ingredients each year, as do several private organizations. Thus, it should be possible to determine where areas of geographic overlap between species and pesticide usage occur. If empirical data on pesticide use or persistence in the environment is lacking geospatial modeling can be used to determine where pesticide use may overlap with affected endangered species.

With the completion of the problem formulations for Ecological Risk, the EPA should now move quickly to begin the informal consultation process for pesticides, starting with a spatial analysis as envisioned as Step one. If this information is collected and assessed properly, then it should then be relatively straightforward for the EPA to begin to develop geographic restriction on the use of pesticides wherever designated critical habitat for a listed species exists as parts of Step Two and Step Three. However, because not all threatened and endangered species have critical

⁴⁶ US Fish and Wildlife Service Environmental Conservation Online System. <http://ecos.fws.gov>

⁴⁷ USGS, National Water-Quality Assessment (NAWQA) Program, Pesticide National Synthesis Project, Annual Pesticide Use Maps: 1992-2013, available at <https://water.usgs.gov/nawqa/pnsp/usage/maps/>

habitat, the EPA will also have to collect data on the distribution and range of species that do not yet have critical habitat to determine whether the use of these pesticides will jeopardize any of those species.

B. Label Requirements.

FIFRA requires that the EPA evaluate and reregister a pesticide every 15 years. During that 15 year period, crop distributions change, use patterns for pesticides change, and listed species change. By the time the registration review process is complete several years from now, additional species will almost certainly be protected by the ESA. Of the species currently listed, some may move towards recovery and become more common while others may become even more imperiled.

Product labels must be able to adapt to changing conditions on the ground to ensure that the use of these pesticides do not cause unanticipated adverse impacts that result in levels of take not authorized through the Section 7 consultation process. Fortunately, the EPA has already developed a system that can address impacts to endangered species and that provides for geographically-targeted conservation measures on the ground through its *Bulletins Live! Two* website.⁴⁸ The Center recommends that whenever a pesticide may affect listed species, both as a precautionary matter and as a mechanism to implement any conservation measures that are implemented in the informal and formal consultation process, the EPA use the *Bulletins Live! Two* system to incorporate these measures. Accordingly, all product labels for pesticides affecting endangered species must contain the following language:

This product may have effects on federally listed threatened or endangered species or their critical habitat in some locations. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the county or parish in which you are applying the pesticide. To determine whether your county or parish has a Bulletin, and to obtain that Bulletin, consult <http://www.epa.gov/espp/>, or call 1-800-447-3813 no more than 6 months before using this product. Applicators must use Bulletins that are in effect in the month in which the pesticide will be applied. New Bulletins will generally be available from the above sources 6 months prior to their effective dates.⁴⁹

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⁴⁸ U.S. Environmental Protection Agency Endangered Species Protection Bulletins.

<http://www.epa.gov/espp/bulletins.htm>

⁴⁹ *Endangered Species Protection Program Field Implementation*, 70 Fed. Reg. 66392 (Nov. 2, 2005).

II. The EPA Must Make Defensible “Not Likely to Adversely Affect” and “Likely to Adversely Affect” Determinations as a Prerequisite for Defensible “Jeopardy” and “No Jeopardy” Determinations.

At the informal consultation stage, the EPA must determine whether the use of a pesticide is either “not likely to adversely affect” (“NLAA”) a listed species or is “likely to adversely affect” (“LAA”) a listed species.⁵⁰ The Services define NLAA as “when effects on listed species are expected to be discountable, insignificant, or completely beneficial.” Discountable effects are those that are extremely unlikely to occur and that the Services would not be able to meaningfully measure, detect, or evaluate” because of their insignificance⁵¹ In the context of pesticides, only if predicted negative effects are discountable or insignificant can the EPA avoid the need to enter formal consultations with the Services. This is *not* a high threshold. The EPA is not required to make a determination as to whether exposure to a pesticide results in population level changes in order to request formal consultations. The Center believes that the Step Two approach described is generally compatible with the mandates of the ESA regarding actions that may affect listed species. The one in a million mortality threshold for “likely to adversely affect” reflects the ESA’s and the Consultation Handbook’s requirements. The decision to consider 1) sublethal effects to species, 2) additive, synergistic and cumulative effects of all chemicals and non-chemical stressors present in the pesticide formulation, tank mixture, and the environment, 3) and the fate and action of pesticide degradates at Step Two is also consistent with the ESA’s requirements and represents an important change from the previous EPA approach, in which the EPA was making policy judgments at Step Two as to whether known, adverse, population-level impacts crossed a severity threshold to warrant consultations.

Finally, the Center notes that at Step Three, the formal consultation process, the EPA and Services must consider the environmental baseline as well as all cumulative effects when determining if the approval pesticides, formulations, or uses will jeopardize any threatened or endangered species. The Services define environmental baseline as “the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process.”⁵² Cumulative effects are defined as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.”⁵³ Pesticide consultations must consider the interactions between the active ingredient under review and other pollutants in the present in the environment.

The Food Quality Protection Act of 1996 (“FQPA”) requires EPA to measure risk of a pesticide based on “... available information concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity.” The EPA has

⁵⁰ U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act*. at 3-1.

⁵¹ *Id.* at xv.

⁵² *Id.* at xiv.

⁵³ *Id.* at xiii.

interpreted this to mean that only pesticides with a common mechanism of action be assessed in a cumulative risk assessment. We strongly disagree with this interpretation. First, the term “other substances” can include chemicals other than pesticides and also stressors that are not chemicals, like radiation and climate change. The EPA itself defines cumulative risk as “the combined risks from aggregate exposures to multiple agents or stressors,” where agents or stressors can be chemicals or “may also be biological or physical agents or an activity that, directly or indirectly, alters or causes the loss of a necessity such as habitat.”⁵⁴ Second, the term “common mechanism of toxicity” does not dictate that the EPA only consider agents or stressors with a common mechanism of action. The National Research Council has recommended that the EPA use the endpoint of common adverse outcome rather than common mechanism of action to group agents that could act cumulatively.⁵⁵ As for how this relates to EPA’s duty under the ESA, cumulative risk in the ESA needs to be interpreted very broadly as this piece of legislation is a precautionary document meant to ensure that no harm comes to listed species. Although the EPA interprets the scope of cumulative risk assessments under FQPA to be limited to the common mechanism effect, **there is absolutely no such written or intended limit in the ESA**. The EPA needs to begin discussions on how it will test true cumulative risk, the way it is broadly defined in the ESA, because current metrics and protocols that measure cumulative risk under FQPA are inadequate for the EPA to meet its legal obligations under the ESA.

Pesticide and their residues and degradates do not occur in single exposure situations and many different mixtures of pesticides occur in water bodies at the same time.⁵⁶ The mixtures of these chemicals can combine to have additive or synergistic effects that are substantially more dangerous and increase the toxicity to wildlife.⁵⁷ Thus, to fully understand the ecological effects and adverse impacts, the EPA and the Services must consider the pesticide’s use in the context of *current* water quality conditions nationwide. In particular, the use of pesticides in watersheds that contain threatened or endangered species and where water quality is already impaired could be particularly problematic. Therefore, the agencies must use the best available data to fully inform its ecological risk assessment by considering water quality.

In conclusion, the EPA should move quickly to assemble the needed spatial data to make an informed “no effect” or “may affect” finding for *each* listed species that will likely overlap with the use of these pesticides or come into contact with its environmental degradates. If there is overlap, EPA must at a minimum conclude that the use of these pesticides “may affect” listed species. Where this occurs, EPA has a choice—(1) the EPA can elect to complete an informal consultation through a biological assessment (also known as a biological evaluation), or (2) the EPA can undergo formal consultation with the Services. If EPA completes a biological

⁵⁴U.S. Environmental Protection Agency 2003. Framework for Cumulative Risk Assessment. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/P-02/001F, 2003. Pg. xvii.

⁵⁵ National Research Council (US) Committee on the Health Risks of Phthalates. Phthalates and Cumulative Risk Assessment: The Tasks Ahead. Washington (DC): National Academies Press (US); 2008. Page 4.

⁵⁶ NMFS 2011, *Endangered Species Act Section 7 Consultation Draft Biological Opinion for the Environmental Protection Agency’s Pesticide General Permit for Discharges from the Application of Pesticides* (hereafter Draft BiOp) at 118-119, lines 4209-31; Gilliom, R.J. et al. 2006. *Pesticides in the Nation's Streams and Ground Water, 1992–2001—A Summary*, available at <http://pubs.usgs.gov/fs/2006/3028/>.

⁵⁷ Draft BiOp at 127-129, lines 4471-4515; Gilliom, R.J. 2007. *Pesticides in the Nation's Streams and Ground Water*, Environmental Science and Technology, 413408–3414.

assessment and implements geographically-tailored conservation measures through *Bulletins Live! Two*, it may be able to reach NLAA determinations via the informal consultation process and alleviate the need for formal consultations. In the alternative, the EPA can move directly to formal consultation after making “may affect” determinations for species where the impacts of pesticides are more complex and will take additional expertise to develop sufficient conservation measures. Cumulative effects need to be measured in Steps 2 and 3.

III. EPA and the Services Must Assess the Adverse Impacts on Critical Habitat.

Section 7 of the ESA prohibits agency actions that would result in the “destruction or adverse modification of [critical] habitat.”⁵⁸ This inquiry is separate and distinct from the question as to whether a pesticide approval will result in jeopardy to any listed species. A no jeopardy finding (or a Not Likely to Adversely Affect finding in an informal consultation) is *not* equivalent to a finding that critical habitat will not be adversely modified. While there is much overlap between these two categories (for example, as in *Tennessee Valley Authority v. Hill*⁵⁹ where the proposed agency action to build a dam would both destroy a species’ habitat and kill individual members of the species in the same time) many agency actions do result in adverse modification to critical habitat without causing direct harms to species that do rise to the level of jeopardy.⁶⁰ Indeed, the ESA’s prohibition on “destruction or adverse modification” of critical habitat does not contain any qualifying language suggesting that a certain species-viability threshold must be reached prior to the habitat modification prohibition coming into force.

As three federal circuit courts have made abundantly clear, avoiding a species’ immediate extinction is not the same as bringing about its recovery to the point where listing is no longer necessary to safeguard the species from ongoing and future threats. Therefore, Section 7 requires that critical habitat not be adversely modified in ways that would hamper the *recovery* of listed species.⁶¹ These potent pesticides with known adverse ecological effects have the potential to adversely modify critical habitat by altering ecological community structures, impacting the prey base for listed species, and by other changes to the physical and biological features of critical habitat. Accordingly, the informal consultation must separately evaluate whether these pesticide products and formulations will adversely modify critical habitat regardless of whether these pesticide products jeopardize a particular listed species. For example, if plant communities alongside a water body that has been designated as critical habitat suffer increased mortality, and this then results in increased temperatures or increased sedimentation, that would represent adverse modification of critical habitat. Likewise, if pesticides are toxic to species lower in the food chain, and a threatened or endangered species feeds on those affected prey species, this impact to the food web would represent a clear example of adverse modification to critical habitat.

⁵⁸ 16 U.S.C. § 1536(a)(2).

⁵⁹ 437 U.S. 153 (1978)

⁶⁰ See Owen, D. 2012. *Critical Habitat and the Challenge of Regulating Small Harms*. Florida Law Review 64:141-199.

⁶¹ See *Gifford Pinchot Task Force v. FWS*, 378 F.3d 1059, 1069-71 (9th Cir. 2004) (finding a FWS regulation conflating the requirements of survival and recovery to be unlawful); see also *N.M. Cattle Growers Ass’n v. FWS*, 248 F.3d 1277, 1283 n.2 (10th Cir. 2001); *Sierra Club v. FWS*, 245 F.3d 434, 441-42 (5th Cir. 2001)

EPA's evaluation must address impacts to critical habitat even if the direct effects on listed species fall below the NLAA or jeopardy thresholds. The Center recommends that the EPA design conservation measures—and implement those measures using *Bulletins Live! Two*—specifically to protect critical habitat of listed species from exposure to pesticides, and where appropriate, prohibit its use altogether in critical habitat where necessary. Doing so would provide meaningful, on-the-ground protections for hundreds of listed species, and may in some cases, help the EPA and the Services then reach a defensible NLAA or “no jeopardy” opinion.

IV. EPA Has an Independent Duty Under the Endangered Species Act to Consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service on the Approval of All End-use Product Labels.

Just as the EPA must consult with the Services regarding the reregistration of an active pesticide ingredient, EPA must also consult with the Services regarding the registration or approval of end use and technical pesticide products. Such consultations must also occur at the earliest possible time to ensure that specific product formulations do not result in jeopardy for a listed species or adversely modify critical habitat.

In addition, because end use formulations may result in mixes of the active ingredient with “other ingredients” before application, the EPA must consider during the consultation process the effects of these “inert” or “other” ingredients together with the active ingredient on listed species and set appropriate conservation restrictions accordingly. As noted in *Washington Toxics Coalition v. U.S. Dept. of Interior*, “other ingredients” within a pesticide end product may cause negative impact to listed species even if they are less toxic than the active ingredient being reviewed.⁶² “Other ingredients,” such as emulsifiers, surfactants, anti-foaming ingredients, and fillers may harm listed species and adversely modify critical habitat. Many of the more than 4,000 potentially hazardous additives allowed for use as pesticide additives are environmental contaminants and toxins that are known neurotoxins and carcinogens.⁶³ The EPA has routinely failed to consult with the Services on the registration of “other ingredients,” potentially compounding harms to listed species by allowing such ingredients to be introduced widely into the environment. EPA must, as part of the consultation process, consider the range of potential impacts by using different concentrations and different formulations of the active ingredient, as well as the potential negative impacts of “other ingredients” used in end use products.

The National Academy of Science report recognized that without real-world considerations of where listed species are located, the relative conservation status of listed species, the environmental baseline, and the interaction of pesticides with other active ingredients, pesticide degradates, and other pollutants, the EPA risk assessment process will not be able to make meaningful predictions about which endangered species will be adversely affected. Until the EPA can conduct realistic assessments, it should take a precautionary approach and enter into formal consultations with the Services as outlined in the *Interim Approaches* document.

⁶² 457 F. Supp. 2d 1158 (W.D. Wash 2006).

⁶³ Draft BiOp at 113, lines 4062-68; 120-121, lines 4262-308; 127, lines 4445-4455; Northwest Coalition for Alternatives to Pesticides, et al., Petition to Require Disclosure of Hazardous Inert Ingredients on Pesticide Product Labels. 2006. http://www.epa.gov/opprd001/inerts/petition_ncap.pdf.

FESTF

**FIFRA Endangered
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August 31, 2016

Ms. Marquee King
USEPA Headquarters
Ariel Rios Building
1200 Pennsylvania Avenue, N. W. - Mail Code: 7509P
Washington, DC 20460

Concerning: Active Ingredient: Dicamba Case number: 0065
Docket number: EPA-HQ-OPP-2016-0223

Dear Ms. King,

In its Registration Review Preliminary Work Plan, EPA has noted that Dicamba has not had a complete endangered species determination performed to allow the Agency to determine whether the uses have “no effect” or “may affect” federally listed species or their designated critical habitats. At such time as an endangered species evaluation is conducted by EPA, the data developed by FESTF, in response to the Agency’s endangered species data requirements, will address species proximity to Dicamba uses.

In June of 2004, March of 2005, October 19, 2007, October 12, 2012, April 22, 2013, and June 1, 2015 the FIFRA Endangered Species Task Force (FESTF, Company Number 73989) submitted its Information Management System (FESTF Information Management System (IMS): Documentation of Structure and Function of IMS 1.1, MRID # 46325901) and documentation of the beta-tested IMS, NatureServe data (FESTF Task Force Information Management System (IMS): Beta-Tested IMS 2.0 and Access to NatureServe Data - Final Report, MRID # 46486301), NatureServe Data Evaluation and Review and description of the NatureServe Dataset Licensed by FESTF (MRID #'s 47260101 and 48969501), listed species attribute and aggregated location data (MRID #'s 48969502, 48969506, 49643402), information related to the proximity of listed species to pesticide use sites (MRID #'s 48969503, 48969504, 48969505 and 49272701), and an evaluation of and access to a licensed dataset containing the spatial locations of golf courses (MRID # 49643403). Additionally, FESTF is developing maps for each federally listed species utilizing FESTF’s aggregated species location data. The species maps are being developed in three phases; Phase 1 maps were submitted on February 20, 2015 (MRID # 49575201), Phase 2 maps were submitted on June 1, 2015 (MRID # 49643401) and Phase 3 maps were submitted on March 24, 2016 (MRID # 49880801). These data fulfill the data requirements spelled out in Pesticide Registration Notice 2000-2 and provide the best available data necessary to support the analysis of Dicamba use and listed species locations and potential exposure.

MEMBER COMPANIES

ADAMA Agricultural Solutions, Ltd.
Albaugh, LLC
AMVAC Chemical Corp.
BASF Corp.
Bayer CropScience

Dow AgroSciences, LLC
DuPont Crop Protection
FMC Corp., Ag. Products
Gowan Company, LLC
ISK Biosciences Corp.

MacDermid Agricultural Solutions, Inc.
Monsanto Co.
Nichino America, Inc.
Nippon Soda Co., Ltd.
Nissan Chemical Industries, Ltd.

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The technical registrants, as identified on the fact sheet included in the Registration Review work plan, Monsanto Company, DuPont, BASF, Syngenta, Albaugh, MacDermid Agricultural Solutions, Inc., as the parent company for Arysta LifeScience North America, which are FESTF members and are entitled to rely on FESTF data (See Attachment A for our current list of members and companies who have reached an agreement allowing reliance on FESTF data submissions).

Sincerely,

(for)

Dan Campbell
Administrative Chairperson, FESTF
Chair, FESTF Administrative Committee
FIFRA Endangered Species Task Force, L.L.C.

cc: Joy Honegger, Monsanto Company
Richard Ambrose DuPont Crop Protection
Jeffrey Birk, BASF Corporation
Dan Campbell, Syngenta Crop Protection, Inc.
Morris Gaskins, Albaugh, LLC
Melinda Bowman, MacDermid Agricultural Solutions, Inc.
Grant Rowland, USEPA

MEMBER COMPANIES

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Albaugh, LLC	DuPont Crop Protection	Monsanto Co.	PBI/Gordon Corp.
AMVAC Chemical Corp.	FMC Corp., Ag. Products	Nichino America, Inc.	Syngenta Crop Protection, Inc.
BASF Corp.	Gowan Company, LLC	Nippon Soda Co., Ltd.	Valent USA Corp.
Bayer CropScience	ISK Biosciences Corp.	Nissan Chemical Industries, Ltd.	

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ATTACHMENT A

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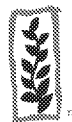
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 ISK Biosciences Corp.

MacDermid Agricultural Solutions, Inc.
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September 13, 2016

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Office of Pesticide Programs,
US Environmental Protection Agency
c/o OPP Docket
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1200 Pennsylvania Ave., NW
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Dear Ms. Guilaran,

Please find enclosed Monsanto's comment on the dicamba preliminary work plan, the ecological problem formulation, and human health draft risk assessment Docket ID No. EPA-HQ-OPP-2016-0223.

Sincerely,

Jerry W. Cabbage, Ph.D.
Regulatory Affairs Manager

**COMMENTS OF MONSANTO COMPANY
ON THE DICAMBA AND DICAMBA BAPMA SALT
PRELIMINARY WORK PLAN (PWP)**

EPA-HQ-OPP-2016-0223

Submitted by:
Monsanto Company
800 North Lindbergh Blvd.
St. Louis, MO 63167

Monsanto Comments on Dicamba and Dicamba BAPMA Salt

Preliminary Work Plan (PWP)

<u>Docket ID No.</u>	<u>Document Name</u>	<u>Text</u>	<u>Page</u>	<u>Comment/Data Needed</u>
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean	Statement: Executive Summary and 5.4.4 Chronic Dietary Risk Assessment: "...most highly exposed population subgroup is children ages 1-2...42% of the cPAD."	5, 37	Comment: The text, while consistent with the select data presented in the summary table in 5.4.6, does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-2016-0223-0002	Memorandum. Dicamba. Acute and Chronic Dietary Exposure Assessments of Food and Drinking Water to Support the Use of Dicamba on Dicamba-Tolerant Cotton and Soybean for Amended Section 3 Registration, and Registration of the New N,N-Bis-(3-aminopropyl) methylamine (BAPMA) Salt Formulation	Statement: Executive Summary: "...most highly exposed...children ages 1-2...42% of the cPAD." VII. Results/Discussion: "...chronic...children 1-2 years old had the highest chronic dietary risk at 42% of the cPAD." IX. Conclusions: "...chronic...Children 1-2...42% cPAD."	2 9 10	Comment: The text, while consistent with the select data presented in summary Table 5 (p 10) does not appear to be consistent with the DEEM-FCID results presented in EPA-HQ-OPP-2016-0187-0011Dietary Exposure Assessment, Attachment 6, which show population subgroup non-nursing infants at 45.4% of the cPAD.
EPA-HQ-OPP-	Memorandum. Dicamba and Dicamba	Statements in 4.3 – 4.5 (including subsections)	20 - 28	Comment: There appear to be inconsistencies both

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2016-0223-0002	BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean			within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. See Appendix 1 to this document for specific comments.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Mysid Chronic Toxicity Test (850.1350) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Daphnid Chronic Toxicity Test (850.1300) using TGAI, dicamba acid (029801)”</i>	4	Comment: This study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using TGAI, dicamba acid (029801) with 1 freshwater and 1 saltwater species for which acute data is available”</i>	4	Comment: These studies have already been submitted. Freshwater (Fathead Minnow): Acute: MRID 48718008 ELS: MRID 48718010 Saltwater (Sheepshead Minnow) ELS: MRID 48718011

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	Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Avian Acute Oral Toxicity Test (850.2100) using TGAI, dicamba acid (029801) with a passerine species”</i></p>	4	<p>Comment: This study has already been submitted. MRID: 48718013</p>
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<p>Data Needs: <i>“Tier 1 Adult Honey Bee Chronic Oral Toxicity (non-guideline) using TGAI, dicamba acid (029801)</i></p> <p><i>Tier 2 Magnitude of Residues in Pollen and Nectar (non-guideline) using representative TEP—may be waived pending the results of the lower-tier honey bee toxicity studies.</i></p> <p><i>Tier 2 Field Testing for Pollinators (850.3040)—may be waived pending the results of the lower tier larval and adult honey bee acute and chronic oral toxicity studies “</i></p>	4	<p>Comment: A chronic study with worker bees has been reported in the published literature which could be used to evaluate the potential chronic effects Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. A bee brood study with dicamba is available from the published literature that could be used to evaluate potential chronic effects of dicamba on newly emerged honey bees. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental</p>

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				Entomology 1:611-614.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“Fish Early-Life Stage Toxicity Test (850.1400) using dicamba’s metabolite, DCSA and the same species as used in the test with TGAI dicamba.”</i>	5	Question: Is the fish ELS study for DCSA required only for a freshwater species?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needs: <i>“For the major degradate, dichlorosalicylic acid (DCSA), additional data on foliar dissipation (835.6100).”</i>	5	Comment: A residue decline study is available for dicamba on dicamba tolerant soybeans. The foliar dissipation of DCSA can be calculated from this study: “Determination of Dicamba Residue Decline in Forage after Application to Dicamba-Tolerant Soybean MON 87708 × MON 89788” MSL0022493. Also, there is foliar dissipation information for dicamba and DCSA in the magnitude of the residue study for dicamba tolerant soybeans: “Magnitude of Residues of Dicamba in Soybean Raw Agricultural and Processed Commodities after Application to MON 87708. MRID 48219901
EPA-HQ-OPP-2016-	Problem Formulation for the Environmental	Data Needs: <i>“Any new formulations for which an Endangered Species Act effect determination must</i>	5	Comment: The request for a Terrestrial Plants Field Study (850.4300) is not discussed elsewhere

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0223-0004	Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	<i>be made must submit Spray Droplet Size Spectrum (840.1100) or Spray Drift Field Deposition (840.1200) and Terrestrial Plants Field Study (850.4300)."</i>		in the Problem Formulation document. Please provide additional information regarding what type of study is being requested.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>"It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury."</i>	9-10	Comment: If EPA is referring to the literature references cited in Footnote 1 on Page 7 of "Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)", it is important to note that none of the studies identified by EPA quantified or assessed vapor drift in any way. All of the reviewed papers intentionally made direct applications of dicamba at low rates to simulate particle drift – not volatilization – in order to assess plant effects at known rates.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Statement: <i>"... no chronic data are available for dicamba's toxicity to freshwater and estuarine/marine fish and invertebrates. The lack of chronic data is considered a major data gap and studies should be submitted using dicamba acid to address this</i>	13	Correction: Chronic studies on fathead minnow, sheepshead minnow, Daphnia magna, and mysid shrimp have been submitted. See Comments above for Page 4.

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	Review of Dicamba	<i>uncertainty.”</i>		
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: <i>“as no empirical data is available for chronic effects to fish and daphnids from either parent dicamba or DCSA, there is no way to ascertain the reliability of the model to predict chronic effects from either parent dicamba or DCSA.”</i>	14	Correction: Chronic studies on fathead minnow and <i>Daphnia magna</i> are available for dicamba. See Comments above for Page 4.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2: Freshwater fish; Chronic (Early Life-Stage); No Data	14	Addition: Fathead Minnow NOAEC = 9.7 mg a.e./L MRID 48718010
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 4: Freshwater invertebrates; Chronic; No Data	14	Addition: <i>Daphnia magna</i> NOAEC = 42 mg a.e./L MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 6 Estuarine/marine fish; Chronic (Early Life-Stage); No Data	14	Addition: Sheepshead Minnow NOAEC = 11 mg a.e./L MRID 48718011

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	Drinking Water Assessments in Support of the Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 1 of Page 15 Estuarine/marine invertebrates; Acute; Grass shrimp EC ₅₀ >100 mg a.e./L	15	Question: EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) has the following endpoint: Grass shrimp EC ₅₀ > 132 mg a.e./L Which is correct?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 6, Row 2 of Page 15: Estuarine/marine invertebrates; Chronic; No Data	15	Addition: Mysid shrimp NOAEC = 11 mg/L MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 7, Row 1: Dicamba dimethylamine salt Bluegill sunfish <i>Lepomis macrochirus</i> & Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 > 112.4 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 > 977 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-	Problem	Table Endpoint:	15	Question:

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HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 8, Row 1: Dicamba sodium salt Rainbow trout <i>Oncorhynchus mykiss</i> 96-Hr LC50 = 111.6 mg a.e./L		The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 507.2 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 8, Row 2: Dicamba sodium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 9.2 mg a.e./L	15	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr EC50 34.6 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table Endpoint: Table 10, Row 1: Dicamba potassium salt Bluegill Sunfish <i>Lepomis macrochirus</i> 96-Hr LC50 = 73.2 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 96-Hr LC50 196 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Table Endpoint: Table 10, Row 2: Dicamba potassium salt Water flea <i>Daphnia magna</i> 48-Hr EC50 = 301 mg a.e./L	16	Question: The value presented in the Reregistration Eligibility Chapter for Dicamba/Dicamba Salts (EPA-HQ-OPP-2005-0479-0008) is 48-Hr

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	Assessments in Support of the Registration Review of Dicamba			EC50 639.8 mg a.e./L. Has there inadvertently been a double correction for % a.e. content of the test substance?
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 1, Line 5: No acute oral data is available for dicamba's toxicity to passerine birds	17	Comment: A study for a passerine species has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Paragraph 2, Line 4: Dicamba is practically non-toxic to honey bees on an acute basis, but no data are available for its acute or chronic toxicity through oral exposure to either adult or larval honey bees.	17	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993). Published literature studies report testing dicamba in a bee brood study and a chronic study with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614.

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EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 1: Birds, Acute Oral	18	Comment: Please clarify which study and endpoint the MRID number 42918001 refers to.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 2 Birds, Acute Oral (passerine) No data		Comment: An acute oral study for a passerine species is available with an endpoint LC50 > 213 mg a.e./kg bw. MRID 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 3 Subacute dietary: TGAI/TEP – 86.8%	18	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) indicates that the TGAI/TAP % ai is 86.6%
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Study Classification: Table 12, Row 3 of Page 19 Terrestrial Invertebrate Acute Contact (adult): The study is classified Supplemental / Quantitative.	19	Comment: The EFED Reregistration Chapter for Dicamba / Dicamba Salts (2005) lists MRID 00036935 as Acceptable. Please provide an explanation

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	Assessments in Support of the Registration Review of Dicamba			for any change in classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 12, Row 4 Terrestrial Invertebrate Acute Oral (adult)	19	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 1 Birds, Acute Oral: Mallard Duck <i>Anus Platyrrhynchos</i> 14-D LC50>282 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >2452 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 13, Row 2 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrrhynchos</i> 8-D LC50>2185 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4533 mg a.e./kg.
EPA-HQ-OPP-	Problem Formulation for the	Endpoint: Table 14, Row 1 Birds, Sub-acute dietary:	20	Comment: Has there inadvertently been a double correction

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2016-0223-0004	Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Bobwhite quail <i>Colinus virginianus</i> and 8-D LC50>2409 mg a.e./kg-bw		for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >9090 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 15, Row 1 of Page 21 Birds, Sub-acute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i> 8-D LC50>609 mg a.e./kg-bw	21	Correction: There has inadvertently been a double correction for acid equivalent content of the test substance. The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >1522 mg a.e./kg. This is consistent with an a.e. correction in the Science Chapter since the test substance was tested at 5620 ppm.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 16, Row 1 on Page 21 Birds, Acute Oral: Bobwhite quail <i>Colinus virginianus</i> 14-D LC50 = 235 mg a.e./kg-bw	20	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as 618 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water	Endpoint: Table 16, Row 1 on Page 22 Birds, Subacute dietary: Bobwhite quail <i>Colinus virginianus</i> and Mallard Duck <i>Anus Platyrhynchos</i>	22	Comment: Has there inadvertently been a double correction for acid equivalent content of the test substance? The EFED Reregistration Chapter

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	Assessments in Support of the Registration Review of Dicamba	8-D LC50>1822 mg a.e./kg-bw		for Dicamba/Dicamba Salts (2005) reported the endpoint for the same study as >4794 mg a.e./kg.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Endpoint: Table 17, Row 2 Chronic (2-Generation Reproduction: Laboratory rat <i>Rattus norvegicus</i> NOAEL = 8 mg a.e./kg-diet/day LOAEL = 78 mg a.e./kg diet/day Endpoints: decreased pup weights	22	Comment: EPA's detailed analysis is not available to Monsanto; however, in general BMDL ₅ is a better, more refined estimate to use as a basis (point of departure) for the chronic risk assessment. In this case, 34.9 mg a.e./kg/day is the most appropriate value to use for the chronic risk assessment.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Study Classification: Table 19, Row 6 Aerobic Aquatic Metabolism: MRID 43758509 is listed as Supplemental	28	Comment: The EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005) classified this study as Acceptable. Please provide an explanation for the change in study classification.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 19, Row 5 of Page 29 MRID 49067704 is indicated to be a Field Volatility Study		Correction: MRID 49067704 is a field dissipation study
EPA-	Problem	Study Classification:	30	Comment:

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HQ-OPP-2016-0223-0004	Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Table 20, Row 14, Page 30 Freshwater fish; Acute: MRID 00258932 is classified as Supplemental / Quantitative		MRID 258932 is classified as Supplemental / Qualitative in the EFED Reregistration Chapter for Dicamba/Dicamba Salts (2005).
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 16, Page 30: Fresh invertebrates life cycle: No data	30	Comment: A <i>Daphnia</i> lifecycle study has already been submitted. MRID 48718007
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 1, Page 31: Saltwater invertebrates life cycle: No data	31	Comment: A mysid lifecycle study has already been submitted. MRID 48718012
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the	Data Needed: Table 20, Row 2, Page 31: Freshwater fish early-life stage: No data	31	Comment: A fathead minnow early-life stage study has already been submitted. MRID 48718010

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	Registration Review of Dicamba			
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 20, Row 4, Page 31: Saltwater fish early-life stage: No data	31	Comment: A sheepshead minnow early-life stage study has already been submitted. MRID 48718011
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 32: Avian oral toxicity: No data on a passerine species	32	Comment: A passerine acute oral toxicity study has already been submitted. MRID: 48718013
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Data Needed: Table 21, Row 2, Page 33: Honey bee adult acute oral toxicity (Tier 1): No Data	33	Comment: An acute oral honeybee study was reported for the EU reregistration of dicamba. LC50 > 100 mg a.e./bee. (Hillsheim, 1993).
EPA-HQ-OPP-2016-0223-	Problem Formulation for the Environmental Fate, Ecological	Data Needed: Table 21 Honey bee adult chronic and larval acute and chronic testing: No Data	33-35	Comment: Published literature studies report testing dicamba in a bee brood study and a chronic study

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0004	Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba			with newly emerged worker bees. Morton, H.L., J.O. Moffett and R.H. McDonald. 1972. Toxicity of herbicides to newly emerged honey bees. Environmental Entomology 1:102-104. Morton, H.L., J.O. Moffett. 1972. Ovicidal and Larvicidal Effects of Certain Herbicides on Honey Bees. Environmental Entomology 1:611-614. These data could be used to evaluate whether chronic exposure to dicamba has any effects on honey bees.
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration Review of Dicamba	Statement: Table 21, Last Row, Page 36 Vegetative Vigor: MRID 47814102	36	Correction: The MRID number should be 47815102
EPA-HQ-OPP-2016-0223-0004	Problem Formulation for the Environmental Fate, Ecological Risk, and Drinking Water Assessments in Support of the Registration	Table A1.	38	Comment: Many of the rates given in this table do not seem to reflect the use rate limitations required in the 2009 Registration Eligibility Decision. Single Application Maximum – 1 lb a.e./A. Annual Application

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	Review of Dicamba			Maximum – 2 lb a.e./A.

`Appendix 1 to Monsanto Comments on Dicamba Registration Review Documents

EPA's Human Health Risk Assessment (HHRA) demonstrates that there is a reasonable certainty of no harm to the general public, including infants and children, from the proposed new uses of dicamba on dicamba-tolerant soybean and cotton.¹ However, EPA's decision to establish a chronic reference dose (cRfD) for dicamba of 0.04 mg/kg/day based on a Point of Departure (POD) of 4 mg/kg/day determined from the 2-generation rat reproduction study with the DCSA metabolite is extremely conservative and appears to lead to inconsistencies both within the HHRA and between the HHRA and Environmental Fate and Ecological Risk Assessment documents. This decision is also inconsistent with (i.e., more conservative than) the conclusions of the Joint FAO/WHO Meeting on Pesticide Residues (JMPR).

Section 5.1.4 of the HHRA states, "Based on available toxicity studies and structural similarities, HED considers the parent and all three metabolites [DCSA, DCGA and 5-OH dicamba] to be of comparable toxicity." This is similar to the JMPR (2010) conclusion that "DCSA and DCGA have toxicity similar to or lower than that of dicamba" while 5-OH dicamba "appears to be of lower toxicity than the parent." In contrast, Section 4.3 of the HHRA indicates that DCSA is approximately 12-fold more toxic to offspring than dicamba acid. The latter statement is apparently based on the most recent EPA conclusions regarding the multi-generation rat reproduction studies with both compounds that were conducted at different times in different laboratories. Although full details are not available, this conclusion appears to be based, at least in part, on different Agency approaches used in evaluating or re-evaluating pup weights. Slight decreases in pup weight or pup weight gain relative to concurrent control were apparently reported in only one generation of both studies at 500 ppm. For DCSA, F1 pup weights at 500 ppm were lower than the concurrent control but were similar to those observed in the F2 controls as well as the laboratory's historical control values and were thus not considered to be a treatment related adverse effect. Although JMPR agreed with this conclusion, EPA concluded that 500 ppm was a Lowest Observed Adverse Effect Level (LOAEL). This resulted in a No Observable Adverse Effect Level (NOAEL) of 50 ppm, the next lowest concentration tested. In contrast, for dicamba, EPA apparently recently concluded that the decreased pup weights reported in one generation at both 500 and 1500 ppm were not treatment related due to the values being comparable to historical control data. EPA thus raised the dicamba offspring NOAEL from 500 ppm to 1500 ppm. It is not clear why comparisons to historical control data were acceptable for dicamba but not for DCSA. However, the end result is that although both the DCSA and dicamba studies appear to have similar marginal responses at 500 ppm, EPA conclusions regarding offspring NOAELs for these molecules are now quite different, 50 ppm and 1500 ppm, respectively. This does not appear to be consistent with the EPA conclusion that the two molecules exhibit comparable toxicity.

The EPA decision to reduce the chronic reference dose (cRfD) for dicamba from 0.45 to 0.04 mg/kg/day and to use this value for dietary risk assessment also does not appear to be justified. DCSA is only a very minor metabolite in conventional crops. Accordingly, the primary source for DCSA in the diet from the proposed uses will be from use of dicamba on dicamba-tolerant soybean (cotton consumption is negligible). However, based on the EPA analysis, potential residues in soybean represent only a very small percentage of the total dietary intake of dicamba. As a result, the vast majority of dietary exposure will be to parent dicamba, not DCSA.

¹ M1768 and M1769 herbicides would also be covered under the current HHRA for dicamba.

Therefore, it would seem more appropriate to assess the risks from these residues utilizing a cRfD based on dicamba data rather than an 11-fold lower cRfD based on a marginal response seen in a DCSA study.

The cRfD of 0.04 mg/kg/day proposed by EPA for use in dietary risk assessment is much lower than the value recommended by JMPR. JMPR concluded that the NOAEL for both the dicamba and DCSA rat reproduction studies was 500 ppm (~35 mg/kg/day for dicamba and ~37 mg/kg/day for DCSA). JMPR then concluded that an Acceptable Daily Intake (ADI) of 0.3 mg/kg/day was appropriate to characterize potential risks to both dicamba and its metabolites. This value was based on the NOAELs from the rabbit teratology and rat reproduction studies with dicamba and a 100-fold uncertainty factor.

Finally, the use of a Point of Departure (POD) of 4 mg/kg/day from the DCSA rat reproduction study for determining the cRfD for dicamba seems inconsistent with information included in the Second Addendum to the Environmental Fate and Ecological Risk Assessment (March 24, 2016). According to that document, EPA has conducted a benchmark dose analysis of the DCSA reproduction study and concluded that the threshold value for the NOAEL would be 8 mg/kg/day and that the lower 95% confidence limit on the benchmark dose resulting in a 5% change from background (BMDL₅) would be 34.9 mg/kg/day. It is not clear why these analyses were not summarized and utilized in the selection of the POD and cRfD in the HHRA.

**Dicamba
Final Work Plan (FWP) Team Meeting
December 1, 2016
PYS-9100
10:00-11:00am**

Team Members

- BEAD: Monisha Kaul, Bill Chism, Claire Paisley-Jones, Andrew Lee, Tim Kiely
- EFED: Michael Wagman, Nathan Miller, William Eckel, Monica Wait, Mark Corbin
- HED: Sarah Dobreniecki, William Irwin, Kelly Lowe, Pete Savoia, Mike Metzger
- PRD: Marqueea D. King (CRM), Melanie Biscoe (TL), Linda Arrington (BC)
- RD: Karen Samek, Kathryn Montague, Grant Rowland, Dan Kenny

1. Introductions

2. PRD Overview

- Status of FWP

3. Team Response to Comments

- Review team responses to public comments (draft)

4. Next Steps

- Publication/review timeline

TOXIC CONCOCTIONS

HOW THE EPA IGNORES THE DANGERS OF PESTICIDE COCKTAILS.



BY NATHAN DONLEY, PH. D.

CENTER FOR BIOLOGICAL DIVERSITY

JULY 2016

Executive Summary

More than 1 billion pounds of pesticides are used in the United States each year, applied to agricultural fields and orchards, residential lawns, playgrounds and parks. Pesticides are often mixed with other pesticides and chemicals before application or after, and the individual ingredients in these mixtures can interact in such a way as to enhance their toxic effects. **This is referred to as “synergy,” and it can turn what would normally be considered a safe level of exposure to people, wildlife and the environment into one that causes considerable harm.**

Although pesticide mixtures in the environment have been extensively documented, the Environmental Protection Agency generally only assesses the toxicity of pesticides individually, in isolation from potential real-life scenarios where these pesticides may interact with other chemicals. The EPA, which is tasked with ensuring that pesticides do not result in unreasonable harm to human health and the environment, often rationalizes this approach by stating that studies measuring mixture toxicity are often not available for analysis.

Our analysis, however, contradicts that claim by utilizing a publicly available information source (data from the U.S. Patent and Trademark Office) that provides a disturbing snapshot of pesticide synergy and the potential for widespread danger to people, waterways and wildlife — risks the EPA has repeatedly failed to identify and consider during its approval process.

For this report we conducted an intensive search of patent applications that were germane to all pesticide products containing two or more active ingredients approved by the EPA in the past six years from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta).

Among our key findings:

- 69 percent of these products (96 out of 140) had at least one patent application that claimed or demonstrated synergy between the active ingredients in the product;
- 72 percent of the patent applications that claimed or demonstrated synergy involved some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, among others, indicating that potential impacts could be widespread.

This suggests that synergistic action between pesticide active ingredients is much better documented and more common than current EPA pesticide assessments would indicate. Further, it appears that pesticide companies are in fact collecting information about the synergistic effects of their products that they are not sharing with the EPA. Recognizing that pesticide synergy data are widely available and that the synergistic relationships between pesticides can have serious implications for human and environmental health, the EPA must now take action to properly consider the potential consequences of pesticide synergy.

Introduction

Pesticide Registration

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), before a pesticide can be sold or distributed in the United States it must be registered — that is, approved — by the EPA. By law the EPA can only register a pesticide if its use will not cause unreasonable adverse effects on the environment.¹ To analyze whether any possible adverse effects may occur, the agency requires that toxicity studies be submitted to it by the chemical companies that plan to sell the pesticide (subsequently referred to as “pesticide registrants”). These studies typically analyze the relative toxicities of the pesticide to different taxa of plants and animals.² Once these data are analyzed, the EPA conducts a cost-benefit analysis that weighs the environmental costs with the purported economic benefits of pesticide use and decides whether or not to register a given pesticide.

The data that are required to be submitted by pesticide registrants almost always involve the use of a single pesticide in the absence of any other added chemicals. In reality pesticide exposures never occur in isolation. Pesticides are typically sold as formulations, meaning the pesticide is mixed with other chemicals in the bottle. These other chemicals can be other pesticides or “inert” ingredients, which are chemical additives that can affect the toxicity or absorption of the pesticide.³ In addition, pesticide products are often mixed in the field before application with other ingredients called “adjuvants”⁴ and/or other pesticide products. Pesticides that are applied on different geographic areas can also migrate away from the site of application and mix together in the environment.⁵ The EPA toxicity data requirements from chemical companies that focus on a single ingredient, combined with the fact that government and academic researchers often don’t have the means to study the vast landscape of mixture toxicity in sufficient detail, leads to an enormous gap in our knowledge of pesticide mixture toxicity.

Chemical Interactions

When chemicals mix in the environment, one of two things can happen: 1) the chemicals can interact in such a way as to change their toxicity profiles or 2) no interaction occurs. When chemicals do not interact, this is generally referred to as “additivity,” which means that no chemical in the mixture influences the toxicity of the other chemical(s) and toxicity can be estimated by how the chemicals act on their own. Alternatively, chemicals can interact to increase or decrease toxicity beyond the sum of the individual effects, which is referred to as “synergism” or “antagonism,” respectively.⁶ Synergism is particularly worrisome from a regulatory point of view, because, if it is not properly taken into account, adverse effects on human health or the environment can be much greater than originally estimated.

The EPA’s current guidance on how to assess mixture toxicity to humans directs the agency to assume that no interaction is occurring as a default unless available data indicate otherwise.⁷ In practice, because of the enormous data gaps on mixture toxicity, the EPA almost exclusively ends up assuming “no interaction” when the agency analyzes mixture toxicity to humans. There is currently no guidance on how the EPA assesses mixture toxicity to plants and animals other than humans, and the ecological risk assessment process does not generally assess pesticide mixture toxicity.⁶

Patent Applications

The extensive gaps in our knowledge of mixture toxicity ultimately weaken the EPA’s ability to effectively regulate pesticides, and new sources of data need to be identified. One new source of data was recently brought to the forefront with EPA’s approval of Enlist Duo, a new pesticide product from Dow that combines glyphosate and 2,4-D into one formulation for use on second generation genetically engineered crops. Following its registration of Enlist Duo, in preparing to defend itself in subsequent litigation on the registration

decision, the EPA came across a patent application from Dow that indicated glyphosate and 2,4-D result in synergistic toxicity to plants. This meant that the EPA's evaluation of the product at the registration phase lacked a full consideration of impacts to nontarget plants, including endangered species. The discovery of this patent application spurred the EPA to further request any relevant data from Dow about possible synergies and ultimately ask a court to vacate its decision to register Enlist Duo.⁸

When a company or individual wants to patent a chemical mixture in the United States, the United States Patent and Trademark Office (USPTO) has to determine whether there is something nonobvious about the mixture that could presumably only be found through research and development done by the applicant.⁹ For chemical mixtures of pesticides, the applicant will often demonstrate this by claiming that the chemicals have synergistic activity. Therefore, when a chemical company applies for patent protection on a mixture of multiple pesticides, it is often accompanied by data that demonstrate synergistic toxicity to the organisms that are going to be targeted by the pesticide mixture.

In the case of Enlist Duo, the fact that publicly available data from a patent application was unknown to the EPA until it was working to defend itself in litigation highlights just how broken this process is. Enormous data gaps, coupled with nonconservative measures of mixture toxicity, have created a precarious framework of assumptions that, in many cases, underestimates the toxicity of pesticide mixtures to humans and the environment.

Analysis

Pesticide Products

For this analysis we sought to understand just how extensive the patent landscape was regarding claims of pesticide synergy. To ensure that our analysis was relevant to pesticide mixtures that were going to be encountered in the environment, we limited it to products that

contain multiple pesticide ingredients (subsequently referred to as "active ingredients"). Specifically, we identified all of the products from four major agrochemical companies (Bayer, Dow, Monsanto and Syngenta — hereafter referred to as "The Big Four") the EPA approved in the past six years that contained two or more active ingredients.¹⁰ This way we identified pesticides that were absolutely certain to be co-applied because they are sold together in a single product. A more detailed description of our methodology is outlined in Appendix A.

We found 140 products from The Big Four, approved between June 2010 and June 2016, that contained at least two active ingredients. Each product contained anywhere from two to six active ingredients, and all were characterized as an herbicide, insecticide or fungicide/nematicide. The largest group of multi-ingredient products from The Big Four that have been approved in the past six years was herbicides, accounting for 67 of the 140 products. A breakdown of the products by company indicates that Bayer, Dow, Monsanto and Syngenta had 49, 26, 5 and 60 products that were included in our analysis, respectively.

Synergy Patents

We then searched various databases for patent applications that made a claim of synergy for at least two of the active ingredients in the product (methodology outlined in Appendix A). Only patent applications submitted to the USPTO were included in this analysis; patent applications in other countries were excluded. All patent applications that were granted, denied or still in the application process were included in our analysis because the status of the application has no bearing on the underlying accuracy of the synergy claims. The USPTO generally does not pass judgment on whether synergy exists or not; it takes applicants at their word, only considering whether the claims are nonobvious and therefore patentable.

Remarkably, of the 140 pesticide products included in our analysis that contain multiple active ingredients, 96 had at least one patent

application that claimed or demonstrated synergy between the active ingredients in the product, a total of 69 percent (Figure 1a and Appendix B). These 96 products had at least one patent application and as many as six, claiming or demonstrating synergy between the active ingredients in the product. The majority of patent applications contained experimental data that were included in the application as evidence of the claimed synergy. For all patent applications, synergy was claimed or demonstrated for target organisms (i.e. synergistic toxicity to target insect species for insecticidal ingredients). A breakdown of the patent synergy claims by company indicates that 71 percent (35/49), 46 percent (12/26), 40 percent (2/5) and 78 percent (47/60) of Bayer, Dow, Monsanto and Syngenta products had patent applications that claimed synergy between at least two of the active ingredients in the product, respectively.

As some of the approved products contained similar ingredients, many patent applications covered multiple products. There were a total of 47 patent applications that covered the ingredient mixtures in the products included in our analysis.¹¹ Many of the ingredients covered by

these patent applications are very widely used, with 72 percent (34/47) of patent applications involving high use ingredients (more than 1 million pounds used per year in the U.S. agricultural sector) (Figure 1b).¹²

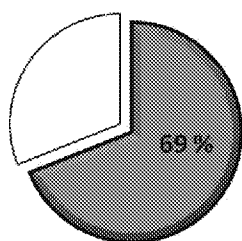
Acuron, a case study

In 2015 the EPA conditionally registered a pesticide product from Syngenta called Acuron (EPA Reg. No. 100-1466, Decision No. 470872). Acuron combines four different active ingredients — bicyclopyrone, S-metolachlor, mesotrione and atrazine — into a single formulation to control weeds in cornfields. The approval of the Acuron product was combined with the approval of the new active ingredient bicyclopyrone, and therefore went through public review and comment.¹³

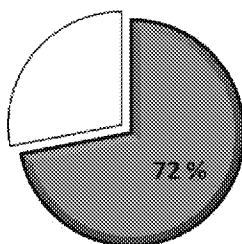
In response to the Center for Biological Diversity's public comments regarding possible synergistic effects of Acuron, the EPA stated: "Concerning synergistic effects, the agency does not routinely include a separate evaluation of mixtures of active ingredients. However, there are some data available to the agency regarding synergistic effects and EPA believes it adequately addressed the issue of synergism between bicyclopyrone and atrazine."¹⁴ But the EPA provides no information on how it addressed this issue of synergism as there is no mention of this analysis in the ecological risk assessment,¹⁵ no separate analysis was provided to the public, and there was no mention of whether synergy was analyzed for ingredient combinations other than bicyclopyrone and atrazine. The agency further indicated that a study of acute toxicity of Acuron to mammals was analyzed and did not indicate synergy was occurring.¹⁴ However, it did not analyze chronic toxicity to mammals or acute and chronic toxicity to all other taxa like birds, fish, invertebrates and plants as a result of Acuron exposure prior to approving this product.

As Acuron is a Syngenta product that was approved in the past six years, it was included in our patent analysis. We found three patent applications claiming synergistic toxicity to plants

Fig 1 A) Percentage of Recently Approved Multi-ingredient Products That Have Evidence of Synergy



B) Percentage of Identified Synergy Patents That Involve High Use Ingredients



from exposure to the ingredients in this product: the combination of 1) S-metolachlor and mesotrione (app # 12374219), 2) mesotrione and atrazine (app # 12675156) and 3) atrazine and S-metolachlor (app # 08930901) (Appendix B). Since bicyclopyrone has the same mode of action as mesotrione,¹⁶ it is likely that any synergy observed with mesotrione and other ingredients will be present with bicyclopyrone and those ingredients as well. Synergistic toxicity of mesotrione and atrazine to certain species of plants has also been extensively documented in the literature.^{17- 22} Finally, in publicly available promotional materials for Acuron, Syngenta has not only claimed that mesotrione and bicyclopyrone work synergistically with atrazine to kill plants, but they have mapped out the exact mechanism by which synergy occurs.²³

It is clear that there are at least three and as many as five layers of synergy that result from the combination of ingredients in Acuron (Figure 2). This synergistic toxicity has been demonstrated for species of plants, and plant health is a very important part of the ecological risk assessment process. EPA's failure to accurately account for toxicity to nontarget plants can lead to damage of crops in nearby fields, harm to endangered or threatened species of plants and harm to vital aquatic and terrestrial plant communities and the wildlife that rely on them. The EPA is charged with ensuring that pesticide use results in no unreasonable adverse effects to the environment or harm to endangered or threatened species. It is still unclear how the agency came to its conclusion for Acuron without properly considering this publicly available, relevant information.²⁴

Fig 2

Synergy Evidence for Acuron (mesotrione, S-metolachlor, bicyclopyrone, atrazine)

Line of evidence	patent claim	published studies	promotional materials	based on mode of action
S-metolachlor + mesotrione	X			
mesotrione + atrazine	X	X	X	
S-metolachlor + atrazine	X			
bicyclopyrone + atrazine			X	X
bicyclopyrone + S-metolachlor				X

Discussion

Our analysis indicates that there are patent applications claiming or demonstrating synergistic action for 69 percent of the recently approved products from The Big Four pesticide companies that contain multiple active ingredients. This percentage is very high and disconcerting. Synergy between chemicals is not generally thought to be a very common phenomenon, which is one reason regulatory agencies typically assume additivity. However, in the case of premixed products, this high percentage makes perfect sense. Combining synergistically acting chemicals into a single product not only allows a company to gain patent protection on the combination of ingredients in their product, but, from a product performance point of view, it makes sense to combine ingredients that will enhance each other's ability. Unfortunately enhancing toxicity to target organisms will often enhance toxicity to many nontarget organisms as well. Perhaps most worrisome is that 72 percent of the patent applications we identified claimed or demonstrated synergy with some of the most highly used pesticides in the United States, including glyphosate, atrazine, 2,4-D, dicamba and the controversial neonicotinoids thiamethoxam, imidacloprid and clothianidin, indicating that potential impacts could be widespread.

We're also certain that 69 percent is an *underestimate* of how many of these products have synergistic activity. There are multiple reasons for this conclusion:

1. We only took into account U.S. patent applications. In our search we found multiple relevant patent applications filed with other countries as well as with the World Intellectual Property Organization (WIPO). For example, a U.S. patent application could not be identified for the product combining methoxyfenozide and spinetoram (EPA reg No. 62719-666), however Dow submitted a patent application

to the WIPO claiming that this active ingredient combination works synergistically to kill an insect target organism.²⁵

2. Many relevant patent applications may not be publicly available yet. The products that we analyzed were approved relatively recently, and it is therefore likely that some relevant patent applications were filed recently as well. The USPTO delays the publishing of patent applications for 18 months after the date of first filing.²⁶ So any patent applications filed within the past year and a half may not be publicly available and would not have been identified by our search strategy.
3. Because “inert” ingredients in pesticide products are not made available to the public, we were unable to search for patent applications that demonstrated synergy between the active ingredients and other ingredients contained in the pesticide product. We did come across many patent applications claiming synergy between the active ingredients in the analyzed products and commonly used “inert” ingredients;²⁷ however, the lack of ingredient transparency in pesticide products prohibited the inclusion of possibly relevant patent applications. Therefore, more layers of synergy may be present in these products than were identified in this analysis.
4. Searching for patent applications is surprisingly difficult. It is possible that our search strategy (Appendix A) missed relevant patent applications.
5. We only searched for claims of synergy in patent applications. As was the case with Acuron, some of these chemical combinations may have been demonstrated to act synergistically on target or nontarget organisms in peer-reviewed scientific studies. Any such study would not have been identified in our analysis. Furthermore, any unpublished, internal studies done by chemical companies would, of course, not be identified either.

Pesticide companies likely possess additional information regarding pesticide synergy that they do not include in their patent applications. Patent applications are very different from scientific studies, which are the typical data source used by the EPA to assess risk. The latter are very descriptive and data intensive, while the former provide the bare minimum of information required to demonstrate to the patent office that their claim is legitimate. This does not necessarily mean that experimental data provided in patent applications are somehow less scientifically valid than data from scientific studies, only that more data may be available from the patent applicant than was provided to the patent office. The EPA acknowledged this fact in the Enlist Duo case by not just relying on the information contained in the relevant patent application, but also requiring Dow to submit any relevant data on the synergy between glyphosate and 2,4-D that was in its possession.⁸ In many cases the patent applicant will have additional data on synergism in their possession, as extensive experimentation is typically done before a company will invest the time and money to develop a product that they intend to market. It is important that this be kept in mind when scientifically evaluating the data contained in patent applications.

We cannot say with absolute certainty that the patent data on synergy that we identified were not used in making registration decisions for these products. There are multiple reasons for this. The first is that, unlike Acuron, many individual products are given approval without public review and comment, so the analysis that went into the product approval, if any, is not shared with the public. Second, even when products do go through public review and comment, a mixture toxicity analysis is either not performed or not outlined in sufficient detail for the public to understand all of the lines of evidence that were used. However, given that, in the case of Enlist Duo, the EPA indicated that it just recently became aware that patent data on synergy exist and the fact that it is not common practice to do a mixture analysis for the ecological risk assessment, we think it is extremely likely

that most, if not all, of these product approvals were made without taking into account this relevant patent information.

It is also unclear why the EPA has not previously been made aware of these patent data by pesticide registrants. Registrants are required to submit information to the EPA that could raise concerns about the continued registration of a product or about the appropriate terms and conditions of registration.²⁸ For example, pursuant to 40 CFR §159.195(a)(3), the registrant is required to submit information that indicates “[u]se of a pesticide may pose any greater risk than previously believed or reported to the Agency.” Data on chemical synergy would certainly fall into that category. It appears that chemical companies are using synergy to demonstrate that chemical combinations have some sort of novelty associated with them and are, therefore, patentable — yet when it comes to the toxicities associated with this synergy, this information never makes it to the EPA.

Recommendations

Searching for patent applications can be a difficult process that takes considerable time and knowledge. Often the pesticide is not referred to by its common name in the patent application, making a simple keyword search insufficient to identify all relevant patent information. The EPA cannot rely on stakeholders to provide all of the necessary information from patent applications, but rather the EPA must place the burden to produce and submit information related to synergistic effects squarely where it belongs: on the pesticide registrant or applicant.

1. Registrants or applicants need to be made aware that failure to submit relevant data to the EPA will be a violation of their duties under Section 6(a)(2) of FIFRA.²⁹ When applicable, enforcement should be pursued when registrants fail to provide those data.
2. To identify patent data that are not affiliated with the pesticide registrant, the EPA needs to use a stepwise approach of

doing a keyword and structure search for patent applications concerning the pesticide of interest followed by a rigorous analysis of the claims in the patent application.

3. Any claims of synergy need to be assessed for relevance given the label restrictions for the pesticide (or lack thereof) and the inert ingredients that are present in any formulation up for approval.
4. Appropriate measures need to be taken to ensure that any registration decision is compliant with FIFRA. This may include label restrictions on mixing, increased in-field buffers, lower application rates or even product cancellation.

A full analysis of mixture toxicity needs to be taken into account for both the human health and ecological risk assessments. When patent applications or other data demonstrate synergistic toxicity to target organisms, that synergy needs to be assumed for all other nontarget organisms within that taxon. For instance if a mixture results in synergistic toxicity to a target insect, like an aphid, then that synergy needs to be assumed for all insects and possibly all other invertebrates in the ecological risk assessment unless available data indicate otherwise. This would be consistent with EPA’s current use of surrogate species to estimate toxicity to other species within the same taxon for the human health and ecological risk assessments. This is one way that the EPA can begin to take into account mixture toxicity given the extensive data gaps that are currently present.

Conclusions

The human health and ecological risk assessments are a key part of the EPA’s pesticide-approval process; without them the agency cannot justifiably conclude that a pesticide can be used without unreasonable harm. When relevant data are not included in the risk assessment, and nonconservative assumptions are made about mixture toxicity, it diminishes the process and ultimately underestimates harm to humans and the environment.

The patent applications identified in this analysis are just the tip of the iceberg. The patent landscape on pesticide mixtures is vast and in no way limited to pesticides that are sold together in formulations. In fact, the implications of this analysis should extend far beyond that of multi-ingredient product approval. The entire pesticide-approval process is designed to narrowly assess the toxicity of individual active ingredients one at a time; yet when most of these active ingredients are being routinely co-applied on agricultural fields across the country, the initial analyses that were done are no longer relevant to real-world

exposure scenarios and are not an appropriate estimate of true risk.

This analysis highlights the shortcomings of such a narrow approach. Since mixture toxicity is such a low priority for the EPA, it is no surprise that relevant information was missed for so long. Clearly pesticide synergy is not a rare occurrence and should no longer be treated as such. The EPA must take into account relevant patent data and other lines of evidence and fundamentally alter its approach to assessing pesticide mixtures.

Appendix A

Methodology of Product Search

We used the EPA's Pesticide Product Label System database to conduct our search.³⁰ In the "company name" search box we searched for "Bayer," "Dow Agrosiences LLC," "Monsanto Company" and "Syngenta Crop Protection," which identified 685, 369, 176 and 539 products respectively. These are all of the pesticide products with "active" status for these four companies as of June 23, 2016 (a total of 1769). To identify the products that had their initial approval in the last six years *and* had multiple active ingredients, we found all active products that had a date on or after June 23, 2010 in the "current status" column. We then searched the pesticide labels of each of those products. If the label indicated two or more active ingredients were present in the product, it was included in our analysis. Of the 1769 active products for these companies, 140 had multiple active ingredients and were first approved by the EPA in the past six years. All of these products are listed in Appendix B.

Methodology of Patent Search

To identify all applicable patent applications, we used a multi-layered search strategy. First, we used the search engines from Google Patents,³¹ FreePatentsOnline³² and the USPTO³³ to do simple keyword searches. The common names of each pesticide were searched concomitantly with the words "synergy," "synergistic" or "synergism." We found many relevant patents using this strategy, but quickly became aware of the limitations of doing a simple keyword search. Many patent applicants do not refer to pesticides by their common name but instead use a common core structure along with various possible side groups to describe the chemicals they want to patent. In order to identify these patents, we used a search engine called SureChEMBL.³⁴ This allows the user to search patent applications for the chemical structure of the pesticide in conjunction with keywords. In addition, we used SciFinder³⁵ to search patent applications by the pesticide's Chemical Abstracts Service (CAS) number and filtered results by other pesticides mentioned in the patent or by the word "synergistic."

All of the patents we identified were further scrutinized. First, any patent application that was not

submitted to the USPTO was discarded. This is because many of the patent applications submitted to other countries that we identified were in a language other than English; however, we note that this discarded information could likely be useful to the EPA. We then went through each of the identified patents and verified that claims of synergy were made for at least two of the active ingredients in the product. If it was stated anywhere in the patent application that a mixture of chemicals acted synergistically to produce toxicities to any organism, that patent was used in our analysis. However, we note that a strong majority of patent applications also contained experimental evidence of synergy.

Notes were taken on each patent included in our analysis, including:

- 1) The company that was listed as the applicant or assignee of the patent application and whether this was different from the registrant of the product.
- 2) The taxa of the organism(s) for which synergy was claimed (plants, insects, fungi, nematodes).
- 3) If there was a possible difference in stereoisomer content of the chemicals in the pesticide product and the patent application. Since lambda-cyhalothrin is a mixture of enantiomers, one of which is gamma-cyhalothrin, any claims of synergy for one was assumed for the other. Similarly, since mefenoxam is one of the two enantiomers that are present in metalaxyl, any claims of synergy for one was assumed for the other.
- 4) If any experimental evidence of synergy was provided in the patent application as well as the magnitude of the synergy as measured by the Colby equation.³⁶ If experimental data were provided in the application and a Colby analysis was performed, the extent of synergy (low, medium and high) was noted for each patent application. The observed response (C_{obs}) and the expected response (assuming no interaction) (C_{exp}) were used to make this determination. If the difference of C_{obs} and C_{exp} was less than 10, that was considered low synergy. If the difference of C_{obs} and C_{exp} was between 10 and 20, that was considered medium synergy. And if the difference of C_{obs} and C_{exp} was greater than 20 or if C_{obs}/C_{exp} was greater than 2, then that was considered high synergy. Also, if experiments were performed but no data were provided, or if experimental data were given but no Colby equation was done, we took note of that as well (Appendix B).

Appendix B

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
7/14/2010	D	62719-616	penoxsulam; cyhalofop												
7/20/2010	S	100-1369	thiamethoxam; fludioxonil; azoxystrobin; mefenoxam	10496187	3	F	S	10170902	1, 7	F	S				
7/25/2010	B	72155-90	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
7/26/2010	B	72155-91	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
7/26/2010	B	72155-89	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
8/2/2010	B	264-1103	lodosulfuron-methyl-sodium; mesosulfuron-methyl												
8/3/2010	D	62719-617	aminopyralid; metsulfuron methyl	12945099	6	P	D								
8/5/2010	S	100-1366	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/5/2010	S	100-1367	difenoconazole; thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
8/6/2010	D	62719-612	penoxsulam; isoxaben												
9/3/2010	S	100-1352	fludioxonil; mefenoxam; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S				
10/14/2010	B	432-1513	trifloxystrobin; triadimefon												
10/29/2010	S	100-1384	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
11/24/2010	S	100-1385	fomesafen; glyphosate												
1/20/2011	B	352-846	aminocyclopyrachlor; chlorsulfuron												
1/20/2011	B	352-848	aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
1/20/2011	B	352-847	imazapyr; aminocyclopyrachlor; metsulfuron-methyl	14172201	2, 4	P	D								
2/16/2011	S	100-1389	pinoxaden; fluroxypyr												
3/2/2011	S	100-1396	fomesafen; glyphosate												
3/10/2011	D	62719-630	2,4-D; aminopyralid	13014909	6	P	D								
3/10/2011	D	62719-628	2,4-D; aminopyralid	13014909	6	P	D								
3/11/2011	S	100-1377	azoxystrobin; propiconazole												
3/11/2011	S	100-1378	azoxystrobin; propiconazole												
3/24/2011	S	100-1393	fludioxonil; mefenoxam	8799310	1, 3	F	S								
4/10/2011	D	62719-629	2,4-D; aminopyralid	13014909	6	P	D								
4/12/2011	S	100-1364	chlorothalonil; acibenzolar-S-methyl												
4/12/2011	B	72155-98	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-99	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-100	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/12/2011	B	72155-101	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
4/26/2011	B	72155-104	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
4/29/2011	B	264-1132	clothianidin; Bacillus-firmus I-1582	12936700	3	I, F, N	B								
5/2/2011	B	72155-102	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/2/2011	B	72155-103	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
5/5/2011	D	62719-637	triclopyr; fluroxypyr												
6/3/2011	S	100-1402	<i>lambda</i> -cyhalothrin; chlorantraniliprole												
6/13/2011	B	72155-105	2,4-D; dicamba; mecoprop-p; indaziflam	13841457	3	P	B	12506456	3	P	B				
6/15/2011	S	100-1399	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
				14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
6/27/2011	D	62719-640	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
8/12/2011	B	72155-106	2,4-D; isoxaben; mecoprop-p; dicamba	13841457	6	P	B								
8/17/2011	B	264-1134	lodosulfuron-methyl sodium; thien carbazon-methyl	12824951	6	P	B								

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/19/2011	S	100-1405	thiamethoxam; abamectin; thiabendazole; fludioxonil; mefenoxam; azoxystrobin	11028776	7	I	S	11563240	6	F, N	S	11028769	7	F, N	S
				14183671	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
11/16/2011	S	100-1410	S-metolachlor; mesotrione	12374219	6	P	S								
12/6/2011	B	264-1135	thiencarbazone-methyl; pyrasulfotole; bromoxynil	12824951	4	P	B								
12/14/2011	S	100-1414	S-metolachlor; mesotrione; atrazine	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
1/11/2012	S	100-1415	azoxystrobin; thiamethoxam												
1/26/2012	B	432-1519	thiencarbazone-methyl; foramsulfuron; halosulfuron-methyl	13902364	5	P	B	12824951	5	P	B				
2/1/2012	S	100-1433	azoxystrobin; difenoconazole	10496185	8	F	S								
2/2/2012	S	100-1427	thiamethoxam; mefenoxam; fludioxonil	13209926	2, 3	F	Bf	8799310	1, 3	F	S				
2/2/2012	S	100-1426	thiamethoxam; mefenoxam; fludioxonil; thiabendazole	11563240	6	F, N	S	8799310	1, 3	F	S				
2/2/2012	B	264-1091	fluopyram; tebuconazole												
2/2/2012	B	264-1090	fluopyram; trifloxystrobin												
2/2/2012	B	264-1085	fluopyram; pyrimethanil												
2/2/2012	B	264-1084	fluopyram; prothioconazole												
2/7/2012	D	62719-646	acetochlor; atrazine												
2/14/2012	S	100-1429	pinoxaden; fenoxaprop-p-ethyl												
2/15/2012	D	62719-645	clpyralid; aminopyralid	13715230	6	P	D	14102818	6	P	D				
2/22/2012	S	100-1428	difenoconazole; mefenoxam												
4/23/2012	S	100-1436	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/23/2012	S	100-1437	thiamethoxam; <i>lambda</i> -cyhalothrin	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
4/27/2012	B	72155-107	metsulfuron-methyl; thiencarbazone-methyl; indaziflam; dicamba	12824951	6	P	B	12506456	3	P	B				
4/30/2012	S	100-1438	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
5/11/2012	B	264-1125	penflufen; clothianidin	11912773	6	I	B								
5/11/2012	B	264-1123	penflufen; prothioconazole	13061976	3	F	B								
5/11/2012	B	264-1122	prothioconazole; penflufen; metalaxyl	10508208	2, 3	F	Bf	12663273	5	F	B				
5/11/2012	B	264-1124	penflufen; trifloxystrobin	12663273	4	F	B								
5/11/2012	B	164-1121	clothianidin; penflufen; trifloxystrobin; metalaxyl	11793763	6	I	B	10486663	6	I	B	12663273	5	F	B
				13209926	2, 3	F	Bf	11912773	6	I	B				
6/20/2012	S	100-1383	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
6/21/2012	S	100-1440	abamectin; thiamethoxam	11028776	7	I	S								
8/2/2012	S	100-1442	S-metolachlor; mesotrione; atrazine	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
8/23/2012	S	100-1449	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin	10496187	3	F	S	10170902	1, 7	F	S				
10/31/2012	S	100-1441	chlorothalonil; difenoconazole	12066894	8	F	S								
12/6/2012	S	100-1455	mesotrione; prodiamine	12374195	6	P	S								
1/15/2013	M	71995-57	glyphosate; diquat dibromide												
1/15/2013	M	71995-56	glyphosate; diquat dibromide												
1/15/2013	S	100-1457	abamectin; thiamethoxam; mefenoxam; fludioxonil	11028776	7	I	S	8799310	1, 3	F	S				
1/22/2013	B	432-1528	indaziflam; diquat dibromide; glyphosate	12506456	6	P	B								
1/23/2013	S	100-1458	<i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
1/30/2013	S	100-1459	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
1/30/2013	S	100-1460	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
3/5/2013	D	62719-655	2,4-D; picloram												
3/7/2013	D	62719-653	2,4-D; picloram												
4/2/2013	D	62719-673	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
4/3/2013	D	62719-671	atrazine; acetochlor												
4/4/2013	D	62719-668	atrazine; acetochlor												
4/4/2013	D	62719-670	atrazine; acetochlor												
6/11/2013	B	432-1527	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
6/12/2013	S	100-1444	thiamethoxam; fludioxonil; difenoconazole	7792845	4	F	S								
6/17/2013	S	100-1470	glyphosate; mesotrione												
6/19/2013	B	72155-110	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
7/22/2013	D	62719-666	methoxyfenozide; spinetoram												
8/8/2013	B	352-845	aminocyclopyrachlor; sulfometuron-methyl; chlorsulfuron												
8/29/2013	D	62719-667	methoxyfenozide; spinosad												
2/3/2014	D	62719-648	cyhalofop; fluroxypyr	12913235	6	P	D								
2/6/2014	S	100-1421	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1422	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/7/2014	S	100-1424	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
2/27/2014	D	62719-679	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	M	524-614	acetochlor; flumetsulam; clopyralid	12074809	3	P	D								
2/27/2014	S	100-1508	thiamethoxam; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				12278731	6	F	S								
4/22/2014	M	524-616	dicamba; glyphosate	13099552	2, 6	P	D	13751021	7	P	M				
5/16/2014	D	62719-680	sulfentrazone; cloransulam-methyl												
5/29/2014	S	100-1527	thiamethoxam; difenoconazole; mefenoxam; fludioxonil; sedaxane	12306870	2, 6	I	B	13209926	2, 3	F	Bf	8799310	1, 3	F	S
				7792845	4	F	S	12278731	6	F	S				
5/30/2014	S	100-1526	difenoconazole; mefenoxam; fludioxonil; sedaxane	8799310	1, 3	F	S	7792845	4	F	S	12278731	6	F	S
6/10/2014	B	264-1168	fenoxaprop-p-ethyl; pyrasulfotole; bromoxynil octanoate; bromoxynil heptanoate												
7/16/2014	S	100-1540	propiconazole; azoxystrobin												
7/29/2014	B	432-1533	foramsulfuron; iodosulfuron-methyl; thiencazone-methyl	13902364	5	P	B	12824951	6	P	B				
9/29/2014	B	264-1170	spirotriamat; imidacloprid	13790375	7	I	B								
10/10/2014	S	100-1555	cyantraniliprole; thiamethoxam	11628145	2, 5	I	Du								
10/15/2014	D	62719-649	glyphosate; 2,4-D	14567574	6	P	D	12147853	6	P	D				
11/12/2014	B	432-1530	imidacloprid; spirotriamat	13790375	7	I	B								
12/2/2014	S	100-1530	sedaxane; difenoconazole; mefenoxam; thiamethoxam	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
12/22/2014	S	100-1549	azoxystrobin; propiconazole; <i>lambda</i> -cyhalothrin; thiamethoxam	12633063	1, 4	I	S	9968173	3	I	M, S	14215205	8	I	S
12/23/2014	S	100-1550	azoxystrobin; acibenzolar-S-methyl												
1/12/2015	S	100-1506	azoxystrobin; difenoconazole	10496185	8	F	S								
1/14/2015	S	100-1554	azoxystrobin; difenoconazole	10496185	8	F	S								
2/6/2015	B	264-1171	imidacloprid; fluopyram												
4/13/2015	M	524-620	acetochlor; fomesafen												
4/21/2015	B	72155-112	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/21/2015	B	72155-113	dicamba; penoxsulam; indaziflam	14026902	2, 7	P	D	12506456	3	P	B				
4/24/2015	S	100-146	atrazine; bicyclopyrone; S-metolachlor; mesotrione	12374219	6	P	S	12675156	6	P	S	8930901	3	P	S
4/27/2015	D	62719-689	cloransulam-methyl; flumioxazin												
7/17/2015	B	72155-114	tau-fluvalinate; tebuconazole												
8/5/2015	S	100-1561	sedaxane; mefenoxam; fludioxonil	8799310	1, 3	F	S	12278731	6	F	S				
8/23/2015	S	100-1450	thiamethoxam; mefenoxam; fludioxonil; azoxystrobin; thiabendazole	11563240	6	F, N	S	10496187	3	F	S	10170902	1, 7	F	S
8/28/2015	D	62719-685	clopyralid; fluroxypyr; pyroxusulam												

First App	Reg	Reg #	Active Ingredients	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl	App #	notes	Taxa	Appl
10/8/2015	B	432-1544	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
10/19/2015	S	100-1556	thiamethoxam; fludioxonil; difenoconazole; sedaxane	12306870	2, 6	I	B	7792845	4	F	S	12278731	6	F	S
10/19/2015	S	100-1559	thiamethoxam; mefenoxam; thiabendazole; fludioxonil; sedaxane	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
11/10/2015	B	11556-186	diflubenzuron; permethrin												
12/9/2015	B	264-1182	penflufen; trifloxystrobin; metalaxyl	12663273	5	F	B								
1/6/2016	D	62719-693	acetochlor; mesotrione; clopyralid	12074809	3	P	D								
2/3/2016	S	100-1564	thiamethoxam; difenoconazole; mefenoxam; sedaxane; cytokinin; gibberellic acid; indole butyric acid	12306870	1, 2, 6	I	B	13209926	2, 3	F	Bf	12278731	6	F	S
2/8/2016	S	100-1568	bicyclopyrone; mesotrione; S-metolachlor	12374219	6	P	S								
2/17/2016	B	264-1184	dicamba; tembotrione												
2/24/2016	D	62719-702	penoxsulam; oxyfluorfen	13014869	6	P	D								
4/11/2016	B	432-1583	imidacloprid; beta-cyfluthrin	9968175	2, 3	I	M								
4/12/2016	S	100-1563	thiamethoxam; thiabendazole; sedaxane; mefenoxam; fludioxonil	12306870	2, 6	I	B	11563240	6	F, N	S	8799310	1, 3	F	S
				12278731	6	F	S								
6/16/2016	S	100-1587	fludioxonil; sedaxane; thiamethoxam	12278731	3	F	S	12306870	2, 5	I	B				
6/20/2016	B	432-1537	fluopyram; trifloxystrobin												

Column 1: Date that the product was first approved by the EPA

Column 2: Registrant of the approved product (D=Dow, M=Monsanto, S=Syngenta, B=Bayer)

Column 3: Registration number of the product. Information on products can be found by searching the registration number on the EPA's Pesticide Product Label System found here:

<https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>

Column 4: A list of the active ingredients found in each product

Column 5: The patent application number. Patent applications can be searched by application number on USPTO's Public Pair Portal found here:

<http://portal.uspto.gov/pair/PublicPair>

Column 6: Notes taken on the patent. **For more detailed information see Appendix A**

1 = Stereoisomer content of a pesticide in the product may differ from that analyzed in the patent.

2 = Applicant/assignee of patent application differs from the registrant of the product

3 = No experimental evidence was provided in the patent application

4 = Experimental evidence was provided in the patent application, which indicated low synergy

5 = Experimental evidence was provided in the patent application, which indicated medium synergy

6 = Experimental evidence was provided in the patent application, which indicated high synergy

7 = Experimental evidence was provided in the patent application but no Colby equation was performed

8 = Experiments were said to be performed but data were not provided in the patent application

Column 7: Taxa for which synergistic toxicity is claimed or demonstrated (P=Plants, I=Insects, F=Fungi, N=Nematodes)

Column 8: Applicant/assignee of the patent (D=Dow, M=Monsanto, S=Syngenta, B=Bayer, Du=Dupont, Bf=BASF)

Columns 9-12: Repeat columns 5-8

Columns 13-16: Repeat columns 5-8

References Cited

- ¹ 7 U.S.C. § 136a(c)(5)(C), (D); 40 C.F.R. § 152.112(e).
- ² EPA. Pesticide Registration: Data Requirements for Pesticide Registration. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/data-requirements-pesticide-registration#nto>.
- ³ Cox, C., and Sorgan, M. (2006) Unidentified inert ingredients in pesticides: implications for human and environmental health. *Environ Health Perspect*, 114(12), 1803-1806.
- ⁴ EPA. Pesticide Registration: Pesticide Registration Manual: Chapter 1 - Overview of Requirements for Pesticide Registration and Registrant Obligations. Accessed 6/20/2016. Available at: <https://www.epa.gov/pesticide-registration/pesticide-registration-manual-chapter-1-overview-requirements-pesticide#adjuvants>.
- ⁵ Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L., Scott, J.C., Stackelberg, P.E., Thelin, G.P., Wolock, D.M. (2006) Pesticides in the Nation's Streams and Ground Water, 1992-2001: U.S. Geological Survey Circular 1291. Available at: <http://pubs.usgs.gov/circ/2005/1291/>.
- ⁶ Lydy, M., Belden, J., Wheelock, C., Hammock, B., Denton, D. (2004) Challenges in regulating pesticide mixtures. *Ecology and Society* 9(6): 1. Available at: <http://www.ecologyandsociety.org/vol9/iss6/art1/>.
- ⁷ EPA. (2000) Supplementary guidance for conducting health risk assessment of chemical mixtures. EPA/630/R-00/002. Accessed 6/21/2016. Available at: <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=20533>.
- ⁸ Respondents' Motion for Voluntary Vacatur and Remand filed in *Natural Resources Defense Council, Inc. v. U.S. EPA*, No. 14-73353 (consolidated with 14-73359), ECF Dkt. No. 121 (filed November 24, 2015 9th Cir.).
- ⁹ 35 U.S.C § 103.
- ¹⁰ Instead of identifying all of the products that were approved in the last six years that have multiple active ingredients, we decided to focus our analysis on just four companies. Our reasoning is that the EPA's pesticide product label database is of limited utility. The only search terms are "product name," "company name" or "EPA registration number." The only way to identify all products approved by date is to search by company, so we focused our analysis on the major players in the agrichemical business.
- ¹¹ The 47 USPTO patent application numbers are: 13014909, 11028776, 12074809, 14172201, 12945099, 12675156, 8930901, 12066894, 9968175, 13715230, 14102818, 12936700, 11793763, 13209926, 10486663, 11628145, 12913235, 9968173, 12633063, 14215205, 13099552, 13751021, 10496185, 10170902, 10496187, 7792845, 12147853, 14567574, 12506456, 13841457, 8799310, 11028769, 11563240, 14183671, 12374195, 12374219, 11912773, 12663273, 13061976, 14026902, 13014869, 10508208, 12278731, 13790375, 12306870, 13902364 and 12824951.
- ¹² Usage information was collected from the USGS National Water-Quality Assessment (NAWQA) Program. Pesticide National Synthesis Project – annual pesticide use maps 2013. Available here: https://water.usgs.gov/nawqa/pnsp/usage/maps/compound_listing.php. High use ingredients (defined as more than one million pounds active ingredient used in the agricultural sector per year in the U.S.) covered by the identified patent applications include: 2,4-D, thiamethoxam, acetochlor, clopyralid, atrazine, mesotrione, S-metolachlor, chlorothalonil, imidacloprid, clothianidin, dicamba, glyphosate, azoxystrobin, bromoxynil.
- ¹³ EPA. Regulations.gov docket number EPA-HQ-OPP-2014-0355. Bicyclopyrone: New Proposed Tolerance in/on Corn commodities and a New Proposed Import Tolerance in/on Sugarcane. Available at: <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2014-0355>.
- ¹⁴ EPA. (2015) Bicyclopyrone: Response to Public Comments on EPA's "Proposed Registration of the New Active Ingredient Bicyclopyrone." Document ID: EPA-HQ-OPP-2014-0355-0076. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0076>.
- ¹⁵ EPA. Memorandum. (2015) Environmental Fate and Ecological Risk Assessment for Use of the New

Herbicide Bicyclopyrone (NOA449280). Document ID: EPA-HQ-OPP-2014-0355-0015. Available at: <https://www.regulations.gov/document?D=EPA-HQ-OPP-2014-0355-0015>.

¹⁶ The United Soybean Board. Take Action. Herbicide Classification Chart. Accessed 6/22/2106. Available at: <http://takeactiononweeds.com/wp-content/uploads/herbicide-classification-chart-2016.pdf>.

¹⁷ Abendroth, J.A., Martin, A.R., Roeth, F.W. (2006) Plant Response to Combinations of Mesotrione and Photosystem II Inhibitors. *Weed Technology*, 20(1), 267-274.

¹⁸ Woodyard, A., Bollero, G., Riechers, D. (2009) Broadleaf Weed Management in Corn Utilizing Synergistic Postemergence Herbicide Combinations. *Weed Technology*, 23(4), 513-518.

¹⁹ Sutton, P., Richards, C., Buren, L., Glasgow, L. (2002) Activity of mesotrione on resistant weeds in maize. *Pest Manag Sci*, 58(9), 981-984.

²⁰ Bollman, S.L., Kells, J.J., Penner, D. (2006) Weed Response to Mesotrione and Atrazine Applied Alone and in Combination Preemergence. *Weed Technology*, 20(4), 903-907.

²¹ Hugie, J., Bollero, G., Tranel, P., Riechers, D. (2008) Defining the Rate Requirements for Synergism between Mesotrione and Atrazine in Redroot Pigweed (*Amaranthus retroflexus*). *Weed Science*, 56(2), 265-270.

²² Walsh, M., Stratford, K., Stone, K., Powles, S. (2012) Synergistic Effects of Atrazine and Mesotrione on Susceptible and Resistant Wild Radish (*Raphanus raphanistrum*) Populations and the Potential for Overcoming Resistance to Triazine Herbicides. *Weed Technology*, 26(2), 341-347.

²³ Syngenta. (2015) Acuron Technical Bulletin. Acuron™ corn herbicide defeats tough weeds current products are missing, Page 22. Downloaded on 6/30/2016 from: <http://www.syngentacropprotection.com/prodrender/imagehandler.ashx?ImID=d40b0089-7648-491d-9d4f-c4f1c92d27bb&fTy=0&et=8>. PDF of bulletin is on file with the authors.

²⁴ The Center has initiated litigation challenging the EPA's failure to consider the impacts of this approval on threatened and endangered species. See https://www.biologicaldiversity.org/news/press_releases/2015/pesticides-06-18-2015.html.

²⁵ Dow Agrosciences LLC, Wang, Peng, Huang, Jim X., Dripps, James E., Yu, Alisa Y. (WO2015196339) SYNERGISTIC EFFECT OF SPINETORAM AND METHOXYFENOZIDE FOR CONTROL OF STEM BORER ON RICE. International patent application # PCT/CN2014/080526, filed June 23rd, 2014.

²⁶ USPTO. USPTO Will Begin Publishing Patent Applications. November 27th, 2000. Available at: <http://www.uspto.gov/about-us/news-updates/uspto-will-begin-publishing-patent-applications>.

²⁷ Bayer Cropscience LP, Reid, Byron L, Baker, Robert B, Bao, Nanggang N, Koufas, Deborah A, Kent, Gerald J, Baur, Peter. (Patent # 8,404,260). Synergistic pesticide compositions. USPTO Application number 12/410,840, filed March 25th 2009. This is an example of a patent application that demonstrates synergy between the active ingredient imidacloprid and commonly used inert ingredients.

²⁸ 40 C.F.R. § 159.195(a).

²⁹ 7 U.S.C. § 136d(a)(2).

³⁰ Found here: <https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>.

³¹ Found here: <https://patents.google.com/>.

³² Found here: <http://www.freepatentsonline.com/search.html>.

³³ Found here: <http://appft.uspto.gov/netahtml/PTO/search-bool.html>.

³⁴ Found here: <https://www.surechembl.org/search/>

³⁵ Found here: <https://scifinder.cas.org>

³⁶ Colby, S.R. (1967) Calculating Synergistic and Antagonistic Responses of Herbicide Combinations. *Weeds*, 15(1), 20-22.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931
DP Barcode: 404823
Date: March 24, 2016

MEMORANDUM

SUBJECT: Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)

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THRU: Mark Corbin, Branch Chief *MC* 3-24-16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (58.1% diglycolamine salt of dicamba (DGA); PC code 128931)] for post-emergent (in-crop) use on dicamba-tolerant cotton (MON 88701, BOLLGARD II® XTENDFLEX™ cotton). Dicamba is currently registered for use on cotton at application rates similar to those proposed for the new use as a pre-emergent and post-harvest application, not to exceed 2 lbs a.e./A per year. The proposed new use is included on the supplemental label of M1691 herbicide for pre-emergence *and* post-emergence (in-crop) use on MON 88701 dicamba-tolerant cotton; this risk assessment is based on the proposed label dated December, 2015. The primary difference between the proposed new use on MON 88701 cotton and the current registration on cotton is the timing of applications. The proposed new use allows

post-emergence applications at a maximum single rate of 0.5 lbs a.e./A; the total in-crop rate (2 lbs a.e./A) is still enforced. This ecological risk assessment only addresses the differences between what is currently registered and the change in the timing of application and incorporates updated toxicological endpoints. References for additional details on the fate and transport properties and effects data for dicamba are provided in the discussion below.

Based on the proposed maximum application rates and exceedances of the Agency's Levels of Concern (LOCs), at the screening level there is a potential for direct adverse effects to Federally endangered and threatened (referred to hereafter as "listed") and non-listed birds (acute exposure only), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This document does not make effects determinations for those taxa where the level of concern for listed species has been exceeded. Further evaluation of the potential for effects to listed species and modification of their critical habitat will be provided in another assessment.

Risks due to off-site spray drift exposure and from runoff are detailed in the Risk Estimation and Characterization section below.

While dicamba exists in either acid form or as one of several salts (including dicamba DGA), bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, submitted effects data indicate similar toxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined (USEPA, 2005a).

Although the risks, based on standard risk assessment methods used by EFED, are not expected to differ from the previous assessment done for dicamba use on cotton (because the rates are similar to those already assessed), there is potential for other ecological concerns that are characterized here, but were not evaluated in the previous assessment on conventional cotton. These concerns are related to a potential increase in usage of dicamba products, the proposed changes in the timing of applications and the fate of dicamba and its metabolite, DCSA, within dicamba-tolerant cotton plants. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport from volatilization related to dicamba use.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial, and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (PC code 029801), dicamba dimethylamine salt - DMA (029802), diethanolamine salt (029803), dicamba sodium salt (029806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for M1691 Herbicide [EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant cotton (MON 87701). Dicamba is currently registered for use on cotton at application rates similar to those

proposed for the new use. The maximum registered application rate for cotton is 2.0 pounds acid equivalent per acre (lbs a.e./A). For the proposed new use on dicamba-tolerant cotton, the maximum single application rate is 1.0 lbs a.e. /A for a pre-emergence application and 0.5 lbs a.e./A for a post-emergence application; the maximum seasonal rate is 2.0 lbs a.e./A.

The primary difference between the proposed new use and the current cotton registration is the timing of the applications. The current registration for dicamba on cotton is limited to pre-emergence and post-harvest applications. The proposed new use on dicamba-tolerant cotton includes applications pre-emergence and/or post-emergence. The proposed post-emergence applications would occur later in the growing season than the current use pattern (but before post-harvest applications), which would increase the potential time period of exposure.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in a sediment:pond water system (MRID 43245208). DCSA is also formed in aerobic soil under laboratory conditions at a maximum of 17.4 % of the applied parent. Toxicity data for DCSA effects to mammals has been submitted to the Agency. No other toxicity data for DCSA has been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**) for aquatic organisms on an acute basis, but may be substantially more toxic on a chronic basis to terrestrial organisms, specifically mammals.

Therefore, this assessment will consider the parent and its degradate DCSA together in the aquatic assessment (with the assumption that dicamba and DCSA are equally toxic), while the terrestrial assessment for mammals will consider parent dicamba and DCSA separately.

Table 1. Toxicity Data for Dicamba and its Degradate DCSA.

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	136 (based on signs of parental neurotoxicity and delayed sexual maturation and decreased pup weight at 450 mg a.e./kg-bw)	8 mg a.e./kg-bw (based on decreased pup weight at 78 mg a.e./kg-bw, using female lactation doses) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute FW Fish (LC ₅₀ ; mg/L)	28	
Chronic FW Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
Footprint WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	180	--

Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

- 1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)
FW=freshwater, NV=non-vascular, V=vascular

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2014) Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean (MON 87708) Clarifying Plant Risks. May 20, 2014. D404138+.
- US EPA/EFED (2011) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708). March 8, 2011. D378444.
- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Turf grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005a) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696
- US EPA (2005b) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705

Consistent with the previous assessments, the environmental fate and effects data used in this assessment are bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt (IPA) and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, the submitted effects data indicate equal toxicity of the acid and salts (based on acid

equivalents). EFED determined that fate studies conducted with dicamba acid provide “surrogate data” for the dicamba salts and that toxicity data across the acid and salts could generally be combined. (USEPA, 2005a)

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant cotton (MON 87701). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the proposed application rates to the dicamba-tolerant cotton. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Table 2. Dicamba DGA Proposed Use Pattern for Dicamba-Tolerant Cotton.

Table 2: Dicamba ECR Proposed Use Pattern for Dicamba-Tolerant Cotton							
Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Application instructions and intervals (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant cotton MON 87701	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	1 ⁴	Pre-plant, at planting, or prior to crop emergence.	1.0	2.0 total	Restricted to ground sprays only
	Post-emergence ¹ (Preharvest)	0.5	4 ⁴	From emergence to 7 days prior to harvest, minimum 7 days between applications	2.0		
¹ - M1691 Herbicide ² - Registered uses ³ - “Acid equivalent” ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

It is common for products like this to be tank mixed with other products and pesticide active ingredients, but the label for this use prohibits tank-mixing with other herbicides and only allows tank-mixes with products that have been tested and found not to increase the likelihood of drift/volatility. EFED recommends that additional guideline laboratory plant testing be required if proposed tank mixes include additional active ingredients to account for potential synergistic phytotoxic effects. Testing of such products should include the standard suite of tested species from the already submitted dicamba and other active ingredient’s vegetative vigor studies as well as those that the open literature and any other data that may indicate potential for synergistic effects.

According to the proposed label, aerial application of dicamba to dicamba-tolerant cotton is not permitted (*i.e.*, it is restricted to ground applications only).

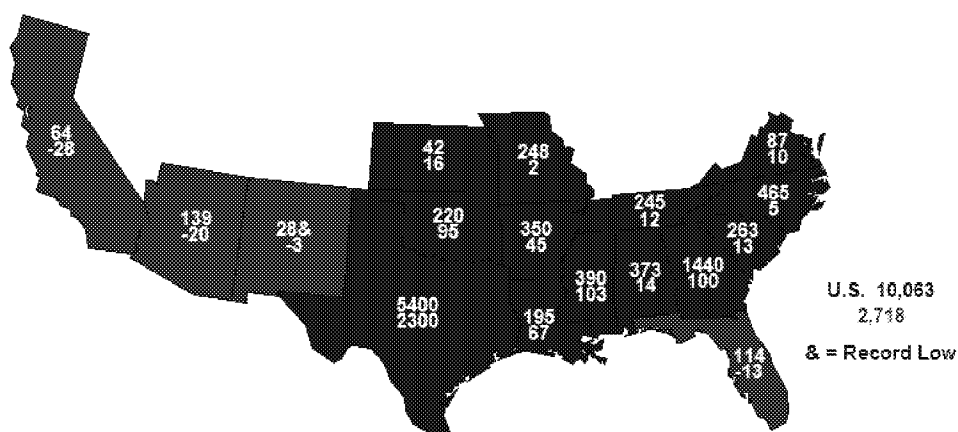
The proposed dicamba registration is for use on dicamba-tolerant cotton (MON 87701). **Figure 1** shows acres of cotton harvested in 2014 in the U.S., per USDA. It is assumed that the new use of dicamba on dicamba-tolerant cotton would be within this 17-state area. The figure indicates that there were approximately 10 million acres of cotton harvested in 2014. The states shaded in red in the diagram below indicate a decrease in harvested cotton acres from the previous year while blue shading indicates an increase in harvested acres from the previous year.

FIGURE 1. Acres of Cotton Harvested By State in the United States in 2014 (based on information from USDA-NASS)

http://www.nass.usda.gov/Charts_and_Maps/Field_Crops/cotnacm.asp



2014 Upland Cotton Harvested Acres (000) and Change From Previous Year



USDA-NASS
08-12-14

ENVIRONMENTAL FATE CHARACTERIZATION

Dicamba is very soluble (6,100 ppm) and mobile ($K_{oc} = 13.4$ L/mg o.c.) in the laboratory, and is

not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs (pKa = 1.9). Dicamba is unstable to aerobic metabolism with half-lives on the order of days, while it is generally stable to abiotic processes, and it is generally more persistent under anaerobic conditions. Dicamba may reach surface water via run-off, spray drift during application, and by vapor drift from volatilization (see analysis below in the volatilization characterization). It is important to note that multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury.¹ Therefore, an analysis of drift from particles volatilized from the treated field was completed (see below). Dicamba is less likely to be available to leach to groundwater because it is so susceptible to aerobic degradation. However, any dicamba reaching groundwater would be somewhat persistent (due to its relatively persistent anaerobic half-life). The major route of exposure to non-target organisms is likely spray drift and runoff. A refined characterization of potential exposures from runoff, spray drift and volatility is presented in this assessment. Available incident reports indicate that visual observations of off-field plant damage have followed dicamba applications and subsequent spray drift and/or volatilization of dicamba residues (discussed below in the incident characterization section).

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA), comprising > 60% of the applied after 365 days of anaerobic incubation in sediment-pond water system (MRID 43245208). DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. This degradate was formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton.

Chemical structures of dicamba and dicamba salts are presented in USEPA, 2011. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in (USEPA, 2005 (EFED Reregistration Chapter); USEPA, 2011).

Aquatic Exposure Estimates

Tier II modeling was performed for dicamba acid and its major degradate DCSA using the Surface Water Concentration Calculator (SWCC v1.106) coupled with the standard pond scenario. The standard Mississippi cotton scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent to DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 3** and **4** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

Table 3. SWCC Input Parameters for Parent Dicamba.

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	3	M1691; EPA Reg. No. 524-582
Interval between applications	7 days	M1691; EPA Reg. No. 524-582
Application Method	Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZ Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZ Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZ Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g o.c.)	13.4 (average)	MRID 42774101
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3)
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423)
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

Table 4. SWCC Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	3	EPA Reg. No. 524-582
Interval between appl. (d)	7 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MScottonSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA
Molecular Weight (g/mol)	207	Product Chemistry

Model Input Variable	Input Value	Source and Comments
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba
K _{oc} (mL/g)	1208 (average)	MRID 43095301
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3)
Aerobic Aquatic Metabolic Half-life (days)	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate input value (2x 24.6d)
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba.

SWCC Modeling Output

Table 5 presents combined SWCC estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant cotton. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

TABLE 5. Combined SWCC Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
MS cotton	42.6 ppb	40.4 ppb	35.8 ppb
EECs represents a combined value for the parent and degradate			

Terrestrial Exposure Estimates

Dicamba-specific Half-Life and Parent Dicamba Exposure Estimates

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. For this cotton new use risk assessment, EFED has refined the estimates of exposure by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application) and a chemical-specific foliar dissipation half-life value for parent dicamba.

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that

there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 6**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 6. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Exposure estimates for terrestrial animals assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX (Terrestrial Residue EXposure model) model (version 1.5.2., 6/11/2013). This model incorporates the Kenaga nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represent an approximation of the highest residue value observed in the data set (Hoerger and Kenaga 1972). Consideration is given to different types of feeding strategies for mammals and birds; including herbivores, insectivores and granivores. For dose-based exposures, three weight classes of birds (20, 100, and 1000 g) and mammals (15, 35, and 1000 g) are considered. The dicamba-specific foliar dissipation half-life of 8.4 days was used for risk estimation. The assessment assumes a maximum single application rate of 1.0 lb a.e./A followed by two 0.5 lb a.e./A applications with a 7 day application interval to estimate terrestrial exposures of dicamba. The dose- and dietary-based EECs (upper bound Kenaga) on a variety of food items from the use of dicamba applied at the maximum labeled rates is provided in **Appendix 1**, along with the full T-REX inputs and output.

DCSA Metabolite Exposure Analysis

The available data indicate that in mammals, DCSA has similar acute toxicity as parent dicamba, but is substantially (17x) more toxic on a chronic basis. DCSA residues following dicamba applications prior to planting conventional cotton are generally considered negligible and would not be of concern (USEPA, 1983 and 1984). However, in dicamba-tolerant cotton plants, DCSA can form in greater amounts (MRIDs 48728701 & 48728703). Based on the available data, EFED evaluated the DCSA metabolite separately from parent dicamba in the chronic terrestrial effects assessment.

Appendix 2 shows residues of dicamba and its metabolites in cotton plants following a number of different treatment regimes (data from MRIDs 48728701 & 48728703). The highest residues for both dicamba and its metabolite DCSA were found in cotton gin byproducts following TRT 4 (4

post-emergent applications of 0.5 lb/A for a total seasonal application rate of 2.0 lb/A) where maximum DCSA residues were approximately 21% of the maximum total dicamba-related residues (6.29 ppm DCSA compared to 23.6 ppm dicamba) while undelinted cotton seed had substantially less residues (0.27 ppm DCSA and 1.54 ppm dicamba). EFED used the maximum values from the empirical data on gin byproducts and undelinted cotton seeds to assess risk from DCSA residues following post-emergent applications of dicamba on DT-cotton plants to terrestrial vertebrates. Gin byproducts for cotton can include a number of different plant parts including fragments of burs, stems and leaf material and immature cottonseed. Since gin byproducts can include various plant parts including immature seeds and since the mature seeds had very low measured DCSA residues (thereby, the immature seeds could potentially be influencing the overall residue concentration when using all gin byproducts), it is possible that the maximum DCSA residues in cotton plant tissues may be slightly higher. Additional data on the distribution of DCSA residues in the various cotton plant parts (*e.g.* stem, leaves) over a broader temporal range would decrease this uncertainty. However, the best available data indicate that DCSA is a much smaller fraction of dicamba related residues in the DT-cotton system and using the maximum empirical residues is considered a conservative approach.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-cotton and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

ASSUMPTIONS AND UNCERTAINTIES

DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It is possible that DCSA may be formed in different amounts in different soil types, and could result in DCSA EECs being under- or overestimated.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba (USEPA 2011, D378444), except for the terrestrial plant endpoints for dicamba DGA and the chronic mammalian endpoints for dicamba acid and the metabolite DCSA.

The risks to terrestrial plants were evaluated using new toxicity information from seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was classified as “supplemental” due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used quantitatively in risk assessment. However, the qualitative data in MRID 47815102 indicate

that the endpoints for this species are likely not as sensitive as the quantitative endpoint for the most sensitive species, soybean (plant height). The new data indicates that the DGA salt may be less toxic to monocots than dicots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

The screening-level risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. The Health Effects Division (HED) recently reanalyzed the data from this study (USEPA, 2016a; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations.

The screening-level risk assessment for the proposed new use on soybeans also used data from a preliminary review of a rat 2-generation study with DCSA (MRID 47899517) which identified a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016a) to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016a) determined BMD₅ (estimated benchmark dose (BMD) to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and

throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba and its Metabolite, DCSA. Test substance was dicamba DGA unless otherwise noted in the footnotes.

SPECIES	ACUTE ENDPOINT	Chronic Endpoint	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L ⁴	No data available	40098001 ¹
Fathead minnow (<i>Pimphales promelas</i>)	LC ₅₀ > 56.4 mg a.e./L ⁵	NOAEC = 9.7 mg a.e./L ⁴	48718010 ² , 48718008 ²
Sheepshead minnow (<i>Cyprinodon variegates</i>)	LC ₅₀ > 180 mg a.e./L	NOAEC = 11 mg a.e./L ⁴	000253901, 48718011 ²
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	NOAEC = 42 mg a.e./L ⁵	40094602, 48718007 ²
Grass shrimp (<i>Palaemonetes purgio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Mysid shrimp	No data available	NOAEC = 11 mg a.e./L ⁴	48718012 ²
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Green algae (<i>Pseudokirchneriella subcapitata</i>)	IC ₅₀ = 7.01 mg a.e./L ⁵	EC ₀₅ ³ = 0.39 mg a.e./L ⁵	48718009 ²
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Zebra finch (<i>Taeniopygia guttata</i>)	LD ₅₀ = 207 mg a.e./kg-bw ⁴	No available data	48718013 ²
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 136 mg a.e./kg-bw (based on neurotoxicity and delayed maturation in parent generation, decreased pup weight at 450 mg a.e./kg-bw)	00078444, 43137101
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,641 ⁶	NOAEL = 8 mg a.e./kg-bw (based on decreased pup weight at 37 mg a.e./kg-bw ⁶).	47899504, 47899517
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	NOAEC = 0.000261 lbs ae/A	47815102
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

³ EC₀₅ value was used in lieu of non-definitive NOAEC.

⁴ Test material was dicamba acid.

⁵ Test material was dicamba BAPMA salt.

⁶ Test material was DCSA

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The aquatic assessment used a total toxic residues (TTR) approach to evaluate risk from dicamba and its metabolite DCSA. An RQ was calculated for aquatic animals based on available data for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (42.2 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (0.4 µg a.e./L divided by 28,000 µg a.e./L), which is below the acute LOC (0.5). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs were not calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for cotton relates to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀/EC₅₀ = 100 mg a.e./L). This is conservative as it assumes that at that dose, 50% of the animals would not have survived, however in these studies there was either no mortality or substantially less than 50% mortality at this dose. In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Chronic RQs for both the fathead minnow and sheepshead minnow would be <0.01, which is well below the level of concern (1.0). However, acute toxicity data indicates rainbow trout are more sensitive than fathead and sheepshead minnows (LD₅₀ of 28 mg ae/L for trout compared to >56.4 for the fathead minnow and >180 mg ae/L for the sheepshead minnow). However, the rainbow trout would have to be more than 270 times more sensitive than the fathead minnow on a chronic basis to result in an exceedance of the chronic LOC. Given that the acute data indicates that dicamba is only slightly toxic to rainbow trout, the likelihood that dicamba is more than 2 orders of magnitude more sensitive on a chronic basis to rainbow trout compared to minnows is considered low. The chronic RQ for aquatic invertebrates is <0.01 based on the most sensitive aquatic invertebrate endpoint of 11 mg ae/L for mysid shrimp.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants for parent dicamba (RQ = 8.5) (see **Table 8**). RQs for non-listed non-vascular aquatic plants and listed and non-listed vascular aquatic plants would all be below the LOC of 1.0.

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Cotton.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	Combined DICAMBA and DCSA Degradate	
			EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	IC ₅₀ > 3,250	42.6 (peak)	<0.013
	Listed species	NOAEC = 200	42.6 (peak)	0.21
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	42.6 (peak)	0.7
	Listed species	NOAEC = 5	42.6 (peak)	8.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

Assessment for Exposure to Dicamba Residues

Birds

The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant cotton is 1.0 lb a.e./A, with a maximum yearly application rate of 2.0 lbs a.e./A. The maximum single application rate of 1.0 lb a.e./A can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lbs a.e./A. EFED used T-REX version 1.5.2 to simulate applications of 1 lb a.e./A, followed by two 0.5 lbs a.e./A at seven-day intervals, with an 8.4-day dicamba-specific foliar dissipation half-life.

In the previous assessments conducted by EFED (USEPA, 2005, 2011), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedances from RQs calculated in T-REX using the 2.0 lbs a.e./A application rate. At the 1.0 plus 0.5 plus 0.5 lb a.e./A application rates, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (large granivore birds) to 2.21 (small birds consuming short grass)] (see **Table 9** and **APPENDIX 1**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.38).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX 1.5.2 for Dicamba Use on Dicamba-Tolerant Cotton.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.21	0.99	0.31
Tall Grass	1.01	0.45	0.14
Broadleaf plants	1.24	0.56	0.18
Fruits/pods/seeds/	0.14	0.06	0.02
Arthropods	0.87	0.39	0.12
Seeds (granivore)	0.03	0.01	<0.01

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and ***bold italicized*** numbers exceed the acute risk LOC for listed species (RQ > 0.1).

Mammals

For mammals, none of the acute RQs from exposure to dicamba exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04 for dicamba). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.01 to 0.10 for dicamba). Chronic dose-based RQs also do not exceed the Agency LOC for chronic risk from dicamba (RQs range from 0.01 to 0.84; see **APPENDIX 1**).

DCSA Chronic Effects Assessment for Terrestrial Organisms

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero and throughout lactation in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who in an avian reproduction test would have been presumed to not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into egg during egg development) or post-hatch.

Empirical data for DCSA are available from magnitude of residue studies reviewed by HED (MRIDs 48728701 and 48728703) for dicamba pre and post-emergent applications (4 applications at a total of 2.0 lbs a.e./A, 4 different treatment groups with differing timing of applications). This data show dicamba and DCSA residues in undelinted cotton seed and gin byproducts (residual cotton plant parts) had maximum residues of 23.6 mg/kg-diet (ppm) dicamba and 6.29 ppm DCSA at 6-7 days following the last application. Using the maximum DCSA residues in gin byproducts (6.29 ppm) or undelinted cotton seed (0.27 ppm) would not result in an exceedance of the chronic LOC for any size class of mammal or bird (RQs would range from <0.01—0.34; **Table 10**). Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods and therefore were considered to contain 4.4 ppm which also would not result in any exceedances (RQ's range from 0.11—0.24).

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-cotton tissues (only measured at one time point) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-cotton plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure. This risk estimation uses the NOAEC endpoint of 8 mg/kg/d. If the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals calculated by HED were used instead, than the maximum chronic RQ would be 0.08. Given that the maximum measured DCSA residues are not close to the NOAEC threshold endpoint (max RQ of 0.34) and the BMDL₅ indicates that biological effects may not be expected even if residues were an order of magnitude higher than indicated by the maximum measured residues, the lack of a plant metabolism study tracking DCSA residues throughout the DT-cotton plant may not be considered a major uncertainty.

Table 10. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-cotton tissues containing DCSA residues (max empirical values of 6.29 mg/kg in broadleaf plant tissue (gin byproducts), 0.27 mg/kg in seeds)

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Broadleaf plant	0.0143	58.25	17.58	0.34
	Seed	0.00318	0.09	17.58	<0.01
Medium (35g)	Arthropod	0.0143	4.19	17.58	0.24
	Broadleaf plant	0.0231	40.33	14.23	0.29
	Seed	0.00513	0.06	14.23	<0.01
Large (1000g)	Arthropod	0.0231	2.90	14.23	0.20
	Broadleaf plant	0.153	9.35	6.15	0.16
	Seed	0.0340	0.01	6.15	<0.01
	Arthropod	0.153	0.67	6.15	0.11

Table 11. Dose-based exposure and risk quotients for birds consuming DT-cotton tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA to birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Broadleaf plant	0.0228	7.17	40.88	0.18
	Seed	0.0051	0.07	40.88	<0.01
	Arthropod	0.0228	5.02	40.88	0.12
Medium (100g)	Broadleaf plant	0.0649	4.08	40.88	0.07
	Seed	0.0144	0.04	40.88	<0.01

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
	Arthropod	0.0649	2.86	40.88	0.14
Large (1000g)	Broadleaf plant	0.291	1.83	40.88	0.04
	Seed	0.065	0.02	40.88	<0.01
	Arthropod	0.291	1.28	40.88	0.03

Beneficial Terrestrial Invertebrates

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum² establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This assessment explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact LD₅₀ > 91 µg a.e./bee (MRID 00036935). If

² <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

an RQ were calculated for terrestrial invertebrates,³ using this non-definitive LD₅₀ (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate (1.0 lbs a.e./A) * 2.7 µg a.e./bee (upper bound for contact exposures from a direct spray of 1 lb a.e./A, based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 (2.7/91) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral LC₅₀ > 100 µg a.e./bee). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC₅₀ (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of 32.12 µg/bee/bee/day (1.0 lb a.e./A * 110 µg a.e./g {upper-bound residue for tall grass from T-REX} * 0.292 g/day {pollen consumption rate}), the resultant RQ would be 0.32 (32.12/100) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than 100 µg a.e./bee, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured.

³ The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at regulations.gov, under docket EPA-HQ-OPP-2012-0543.

Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the cotton risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ⁴	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁵

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated

⁴ Test material was dicamba BAPMA salt

⁵ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

contact-based bee chronic NOAEC of 38 $\mu\text{a.e./bee}$. The acute dietary estimated exposure level for adult honeybees is 32.12 $\mu\text{g/bee/day}$ for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 $\mu\text{g a.e./bee}$. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate

developmental life stages and survival in organisms following prolonged exposure); and

2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the cotton risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning later in 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-cotton plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumptions and incorporation depth are based upon the use and related application method and can be found in **Appendix 3**.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of

dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant cotton are presented in **Tables 12 and 13**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 12. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Cotton

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Cotton	1.0	0.06	0.51	0.01

Table 13. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba DGA through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	Listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. Risk quotients would be higher if the maximum seasonal rate (2 lb a.e./acre) were applied all at once. Moreover, using default assumptions in AgDrift (Tier 1 ground, low boom, fine to medium-coarse spray) the LOC for both listed and non-listed dicots (using the most sensitive species, soybean, data, **Table 6**) is exceeded at the maximum distance that the model returns (997 feet). However, the draft label contains language restricting applications to a specific nozzle with coarser droplet spectra and other restrictions. The implications of these restrictions on spray drift are discussed in the following section.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to. However, since the vegetative vigor endpoints for dicamba DGA to soybean are an order of magnitude more sensitive than any seedling emergence endpoint for dicamba acid, this is considered a minor data gap and the major route of concern for terrestrial plants is considered to be spray drift of dicamba residues following dicamba DGA applications.

Spray Drift Analysis for Exposure to Terrestrial non-Target Organisms

As the application rates are identical between the post-emergent use of dicamba on tolerant-soybean and tolerant-cotton, the following analysis that was conducted for the concurrently issued 2nd addendum for use on tolerant-soybean (USEPA, 2016b; D426789) is also applicable for the present action on cotton.

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that a realistic distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate) or approximately double that for the pre-emergent max application rate of 1.0 lb/A. However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-course droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect distance for sensitive plants (the "no-effect" distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto's statement that the field trial data are not suitable for use in EPA's regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED’s Process to Determine a “No Effect” Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered “controls,” though there are considerable uncertainties to this approach. Specifically,

no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these “controls” the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the “control” means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a “no effect” distance at each site was considered the first distance greater than a distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the “no effect” distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.i./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 14. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Conclusions for the field trial data and weight of evidence approach for spray drift

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of the data is not suitable for the purpose of establishing a quantitative buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum for soybeans (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.i./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTI11004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.i./A application rate with nozzles and operating pressures that at a minimum restrict droplet spectra to ultra-coarse and extremely coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

Vapor Analysis for Drift Exposure to non-Target Organisms

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, as these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 pound per acre application rate and 220 feet for the 1.0 pound per acre application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the following section (EIIS incident number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (*e.g.* cooler temperatures)

Incident Data

A preliminary review on January 20, 2016, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 11 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment. The EIIS database identifies numerous additional ecological incidents with the dicamba acid (70 incidents) and various dicamba salts (104 incidents across all salts). EFED investigated whether any of the incidents in the database were associated with dicamba use on dicamba-tolerant crops. Four of the 11 incidents in the EIIS database involving the DGA salt involved applications to dicamba-tolerant soybean and resulting damage to non-dicamba tolerant crops. No incidents are currently reported in the EIIS database for incidents stemming from the use on DT-cotton, however recent information submitted by Missouri and Arkansas regulatory agencies (discussed below)

include incidents associated with the use of dicamba on DT-cotton that occurred in 2015. Details on the recent incidents stemming from use on DT-soybean and cotton are provided below.

In addition to the review of the available incident databases, EFED is aware of other recent incident information where non-dicamba tolerant plants were damaged following applications of dicamba DGA salt to DT-soybeans or DT-cotton. This recent incident information, submitted by Monsanto and state regulatory agencies in Missouri and Arkansas, is discussed below.

Recent Incident Information Provided by Monsanto and MO and AR Regulatory Agencies

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (*e.g.* burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (*e.g.* leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EHS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. Pesticides were applied using XR T-Jet 11004 nozzle, which is the same nozzle proposed for the new dicamba uses on DT cotton. The applicator was informed of this incident in January 2014. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two taken samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8 µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty regarding whether

this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where “dicamba type” damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto’s submitted information on the 73 incidents from 2012-2014. With the current information and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri) on cotton. The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site, but the provided incident information did not provide sufficient details to ascertain damage to EPA’s apical endpoints of plant height or yield. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made. Results of residue analyses for these incidents are currently not available.

Conclusions Regarding Incident Information 2012—2015

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean and cotton crops, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that differ from the draft label being evaluated here include the restriction against tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of

visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize as the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory conditions for which EPA has data.

Runoff

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). The fate characteristics of dicamba indicate that it is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 4** for calculations). Using these assumptions in

TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 4**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

Herbicide Interactions (Synergism)

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard

suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

FEDERALLY-LISTED SPECIES

This assessment does not include effects determinations for any identified federally-listed endangered and threatened species (listed species). A more in-depth listed species-specific effects determination will be conducted using the information from this analysis. The identified potential risks to listed species from this screening-level risk assessment are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Screening Level Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Cotton.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ²
Terrestrial and semi-aquatic plants – dicots	Yes	Yes ²
Insects	No	Yes ²
Birds	Yes (Acute)	Yes ²
Terrestrial phase amphibians	Yes (Acute)	Yes ²
Reptiles	Yes (Acute)	Yes ²
Mammals	Yes (Chronic)	Yes ²
Aquatic plants	Yes (Non-vascular)	Yes ²
Freshwater fish	No	Yes ²
Aquatic phase amphibians	No	Yes ²
Freshwater crustaceans	No	Yes ²
Mollusks	No	Yes ²
Marine/estuarine fish	No	Yes ²
Marine/estuarine crustaceans	No	Yes ²

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid.

DGA salt rapidly disassociates into dicamba acid.

²The listed chronic LOC was exceeded for mammals, birds and dicot species of plants. Therefore, the potential for adverse effects to those species that rely on a specific animal species, multiple animal species, or dicot plant species cannot be precluded in the screening-level assessment. Indirect effects may include general habitat modification, loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, and/or mammals for some stage of their life-cycle. Further refinement for the endangered species assessment is provided in a separate document that includes species-specific effects determinations.

UNCERTAINTIES

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on cotton as a result of this expanded new use [lbs acid equivalent (a.e.) applied per year] could potentially increase when compared to historical dicamba usage data. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant cotton is predicted to increase given the recent resistance issues identified in glyphosate-tolerant crops (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increased usage.

Additionally, applications during a warmer time (*i.e.*, post-emergence as would be included in the proposed new use) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, though this is uncertain and requires additional evaluation. Provided the in-field buffer restricts spray drift/volatility of dicamba residues to the field, effects to non-target plants should be limited. For endangered species determinations (assessed in separate documents published concurrently with this risk assessment), effects to listed species critical habitat from the use of dicamba on dicamba-tolerant cotton will be considered.

It is also possible that the proposed new use of dicamba on dicamba-tolerant cotton may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used. Weed resistance issues are being considered by the Biological and Economic Analysis Division (BEAD) through product labeling and stewardship efforts.

The formation and persistence of dicamba's metabolite, DCSA, is an uncertainty that impacts the terrestrial animal risk assessment. Plant metabolism studies that evaluate DCSA residues in DT-cotton plant tissues over time would decrease this uncertainty. However, the best available data indicate that residues of DCSA in DT-cotton plants are unlikely to result in risk to terrestrial animals.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

TREX MODEL INPUTS

You must enable macros for this spreadsheet to work correctly

These values will be used in the calculation of exposure estimates for foliar, granular, liquid and/or seed applications of pesticides.

Chemical Identity and Application Information

Chemical Name:	Dicamba	
Seed Treatment? (Check if yes)	<input type="checkbox"/>	Seeding Rate (lbs/acre)
Use:	cotton, all or unspecified	18.9
Product name and form:		
% A.I. (leading zero must be entered for formulations <1% a.i.):	100.00%	
Half-life (days):	8.4	
Are you assessing applications with variable rates or intervals?	yes	

For HETI specify application day at Column F and % of day for up to 30 applications

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Reset Model

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
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19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian			
Endpoint	Toxicity value	Indicate test species below	Optional Test Organism Body weight (g)
LD50 (mg/kg-bw)	188.00	Bobwhite quail	
LC50 (mg/kg-diet)	10000.00	Bobwhite quail	
NOAEL (mg/kg-bw)		Bobwhite quail	
NOAEC (mg/kg-diet)	695.00	Mallard duck	
Enter the Mineau et al. Scaling Factor		1.15	Optional Test Species Name
Mammalian			
Size (g) of mammal used in toxicity study		Acute Study	Chronic Study
Default rat body weight is 350 grams		350	350
Endpoint	Toxicity value	Reference (MRID)	
LD50 (mg/kg-bw)	2740.00		
LC50 (mg/kg-diet)			
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		
Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose		2720	mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.00
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.00
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	

Size Class (grams)	Adjusted LD50	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.00
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.00
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.00

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.00
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.00
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.00

Appendix 2. Dicamba and DCSA Residues from Dicamba-Tolerant Cotton Crop Field Trials

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A

Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.

Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Media n	Mean	Std. Dev.
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

Appendix 3. TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Cotton

Green values signify user inputs (Tables 1, 2 and 4).

Input and output guidance is in popups indicated by red arrows.

Table 1. Chemical Identity.	
Chemical Name	Dicamba-DGA salt
PC code	128931
Use	Cotton
Application Method	Ground
Application Form	Spray
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	y
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Dicamba-DGA salt. Units in y.		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in y.				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Dicamba-DGA salt through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Appendix 4: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in Table 1 for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in Figure 1. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in Tables 2 and 3.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%).

In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40 °Lat	105
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

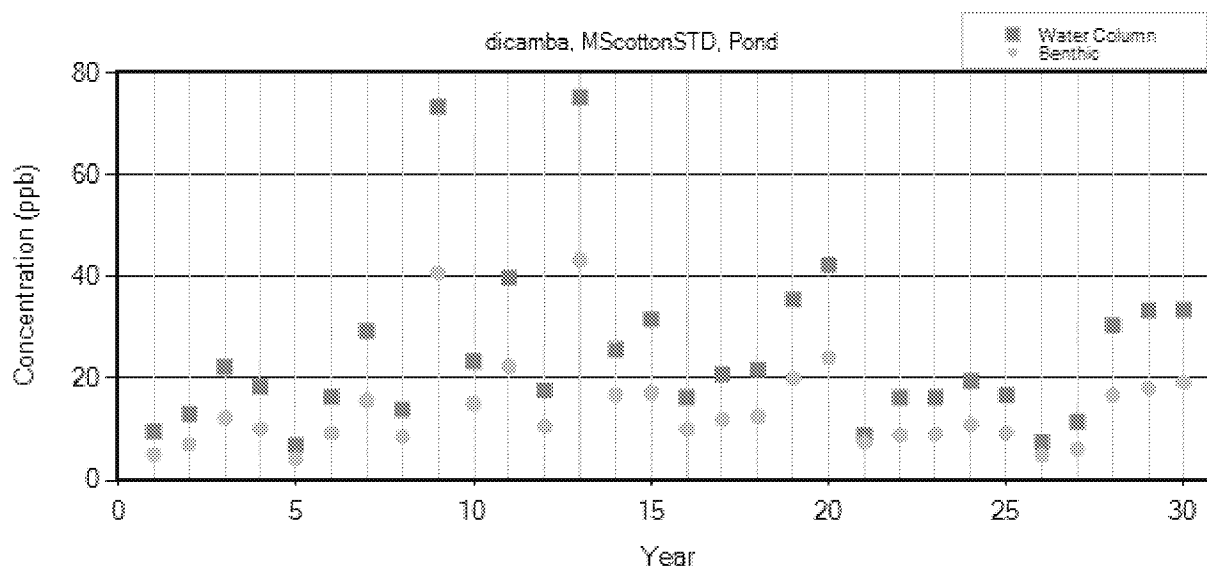


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

EEC lb a.e./Acre = (Z mg/L) * (102,790 L water/ Acre-in) * (1 inch) * (1 lb/ 453,592 mg) which reduces to:

Equation 2.

EEC lb a.e./Acre = (Z mg/L) * (0.226613)

EEC lb ai/A = 0.061 mg/L * 0.226613 = 0.0138

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be

EEC lb ae/A = 0.005 mg/L * 0.226613 = 0.0011. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e/A application rate and 0.06% loss through runoff and erosion.			
Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

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420352, 421434, 421723

Date: March 24, 2016

MEMORANDUM

Subject: Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin).

To: Grant Rowland, Risk Manager
Kay Montague, Product Manager Team 23
Dan Kenny, Branch Chief
Herbicide Branch
Registration Division (7505P)
Office of Pesticide Programs

From: Elizabeth Donovan, M.S., Biologist *ED* 3/24/16
Michael Wagman, M.S., Biologist *MW* 3/24/16
Monica Wait, Risk Assessment Process Leader *Monica Wait* 3/24/16
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Through: Mark Corbin, Branch Chief *Mark Corbin* 3-24-16
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Prior to conducting this refined Endangered Species Assessment, the Environmental Fate and Effects Division (EFED) performed a screening level ecological risk assessment for a Federal action involving proposed new uses of the diglycolamine salt of dicamba (dicamba DGA) on dicamba herbicide-tolerant soybean on March 8, 2011 (DP 378444); an amendment to the assessment was issued on May 20, 2014 (DP 404138, 404806, 405887, 410802, and 411382). Concurrent with this refined Endangered Species

Assessment, a Section 3 New Use dicamba DGA salt on dicamba-tolerant cotton screening-level assessment (DP 404823) and a subsequent addendum for the use of dicamba DGA on dicamba-tolerant soybean (DP 426789) that addresses multiple issues (risk to terrestrial invertebrates, spray drift buffers, runoff, and updated mammalian toxicological endpoints for parent dicamba and its degradate DCSA) have been finalized. As a result of the analyses in the screening level risk assessments and the new addendum (DP 426789), potential direct risk concerns could not be excluded for:

- mammals (chronic, from the soybean use only, due to residues from dicamba's metabolite, DCSA, rather than from parent dicamba);
- birds (acute from parent dicamba for both soybean and cotton uses; chronic from DCSA residues only in soybean but not cotton), considered surrogates for reptiles, and terrestrial-phase amphibians; and
- terrestrial plants (soybean and cotton uses).

In the screening level risk assessments, indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Additionally, the screening level assessment showed that direct risk concerns were unlikely (*i.e.* levels of concern were not exceeded) for:

- mammals (acute) and (chronic—for the cotton use only);
- birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton);
- terrestrial insects (acute and chronic);
- freshwater fish (acute and chronic);
- aquatic-phase amphibians (acute and chronic);
- estuarine/marine fish (acute and chronic);
- freshwater invertebrates (acute and chronic); estuarine/marine invertebrates (acute and chronic); and
- aquatic plants¹

The screening assessment for dicamba DGA on dicamba-tolerant cotton (D404823) and the recent addendum to the screening level risk assessment for the use of dicamba DGA on dicamba-tolerant soybean (D426789) used updated terrestrial mammal endpoints for dicamba and its metabolite, DCSA.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each screening step, EPA compares the more refined exposures to the toxicity of the pesticide active

¹ The listed species LOC was exceeded for non-vascular aquatic plants, however there are no listed species of this taxa.

ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still exceeds the Agency’s levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. When a given taxonomic RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon. If RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

The purpose of this document is to explain the refined risk assessment conducted for Federally-listed threatened or endangered (listed) species that could potentially be impacted by this pesticide registration. The refined assessment was conducted based on the 2004 Overview document, as discussed above. The assessment of risks to listed species posed by the use of Dicamba DGA has been conducted in phases covering a specific set of states, assessing risk to all the listed species covered in those states. This assessment covers the endangered species analysis for 16 states: Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin. Based on EFED’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), 183 species in the 16 states proposed for registration were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant soybean and cotton uses. **Table 1** presents a summary of this assessment. Separate concurrent assessment phases cover the endangered species analysis for 7 states (D422305, covering AL, GA, KY, MI, NC, SC, and TX) and 11 states (D425049, covering AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV).

EPA consulted U.S. Fish and Wildlife Service Recovery Plans to determine whether listed species in these states would be expected to occur in an action area encompassing the treated soybean and corn fields. The refined assessment was then conducted on those species that could not be excluded from the action area. EPA also consulted the recovery plans in the refined assessment for additional habitat information and incorporated species biological information regarding dietary items (used to model dicamba DGA residues in prey tissue) and body weight (used to determine food consumption rates and scale ecotoxicity data from the tested surrogate species, the bobwhite quail and rat, to the body weight of the listed species).

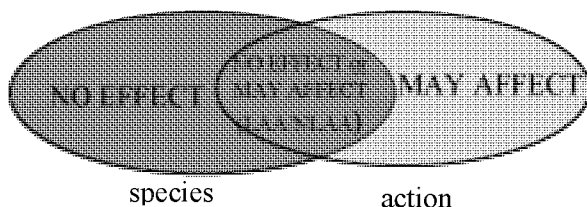
Table 1. Summary of species effects determinations and critical habitat modification determinations for Federally listed threatened or endangered species in AR, IL, IA, IN, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI for dicamba DGA use on genetically modified cotton and soybeans.

Species	Effects Determination	Comments
Spring Creek Bladderpod	May Affect, Likely to Adversely Affect	Found in Wilson Co., TN
All other species (terrestrial and aquatic)	No Effect	None
Critical Habitat	Modification Determination	Comments
All Critical Habitats	No Modification	None

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have **NO EFFECT**.
- For listed individuals outside the action area, use of a pesticide would be determined to fall under **NO EFFECT**.
- Listed individuals inside the action area may either fall into the **NO EFFECT** or **MAY AFFECT** (**LIKELY** or **NOT LIKELY TO ADVERSELY AFFECT**) categories depending upon their specific biological needs, circumstances of exposure, etc.



- **LIKELY** or **NOT LIKELY TO ADVERSELY AFFECT** determinations are made using the following criteria:
 - Insignificant - The level of the effect cannot be meaningfully related to a “take.”
 - Highly Uncertain - The effect is highly unlikely to occur.
 - Wholly beneficial - The effects are only good things.

Spray Drift Mitigation

EFED's refined endangered species risk assessment took into account the spray drift mitigation language that was added to the most recent proposed label submitted by the registrant. An accounting of federally-listed threatened or endangered species within the 16 states (covered in this assessment) proposed for dicamba DGA use on genetically modified cotton and soybeans is included in **Appendix 1** (183 species). Specifically, the spray drift mitigation language on the M1691 Herbicide Supplemental labels for the use dicamba DGA salt on **ROUNDUP READY 2 XTEND™** soybean and **BOLLGARD II® XTENDFLEX** cotton includes the following limitations:

- Specifying the use of a nozzle (Tee Jet® TTI1004) with ASABE S-572 ultra-coarse and extremely coarse droplet spectra and a maximum operating pressure of 63 psi.
- A maximum equipment ground speed of 15 miles per hour and ground boom height of 24 inches above the target pest or crop canopy.
- Restricting all applications when wind speeds are < 3 mph or > 15 mph and restricting applications when wind is blowing towards sensitive areas at > 10 mph. Maintaining use of a 110 foot in-field buffer for a 0.5 lb a.i./A application (220 foot in-field buffer for a 1 lb a.i./A application) when the wind is blowing towards any areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures.
- Applications done in low relative humidity conditions are to use equipment set to produce larger droplet spectra to compensate for evaporation.
- Applications are not be conducted during temperature inversions.
- In order to prevent effects to non-target susceptible plants, the label also includes the following language: “do not apply under circumstances where spray drift may occur to food, forage or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants because severe injury or destruction may result, including plants in a greenhouse. Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from the off-target movement of M1691 Herbicide. The Applicator must survey the application site for neighboring sensitive areas prior to application. The applicator also should consult sensitive crop registries for locating sensitive areas where available.”
- Finally, in order to prevent unintended damage from the drift of M1691 Herbicide, the label says not to apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

The incorporation of the spray drift mitigation measures into the product labeling as outlined above would result in exposure to dicamba DGA from spray drift at a level where effects are expected only within the confines of the treated field and so the action area is limited to the dicamba DGA treated field. Further, the incorporation of the “susceptible plants” spray drift mitigation language on the label is to avoid damage to these plants (including adjacent crops). Because the risk assessment interprets the threshold for plant damage concern to be based on the most sensitive plant species tested and the screening level ecological risk assessment has demonstrated that these plant effects endpoints constitute the most conservative terrestrial organism levels of effect, it is concluded that the “susceptible plants” requirement requires a level of drift mitigation that would also prevent less sensitive organisms from being exposed at levels of concern. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to dicamba DGA, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any effects thresholds of concern. Additionally, as indicated in the screening level ecological risk assessments for cotton and soybean, no aquatic receptor taxa are of concern for drift or runoff exposure (LOCs were not exceeded for aquatic taxa). **Consequently, all but 10 of the listed species originally identified as potentially at-risk are determined to be given a “no effect” (NE) without further refinement because they are not expected to occur in an action area encompassing the treated soybean and cotton fields (Appendix 2).** The remaining 10 species are assessed using the refinements set forth in the 2004 Overview document referred to earlier in this assessment.

Exposure through Runoff

The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted concentrations from modeling were lower than the most sensitive taxa's endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a "no effects" determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would also protect against the risk of exposure to listed species off the treated field.

In addition to the spray drift and runoff mitigation measures contained in the proposed labeling, EFED analyzed species-specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment. An accounting of the federally-listed threatened or endangered species within the 16 states proposed for this registration showed 183 listed species as potentially at risk (direct or indirect effects) as a result of the screening-level assessment (**Appendix 1**). The spray drift mitigation label language cannot preclude listed species being exposed to dicamba DGA salt or DCSA residues on treated fields, should a listed species utilize such areas as part of its range and corresponding habitat. Of the 183 listed species within the 16 states (AR, IL, IN, IA, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, WI) considered part of the proposed Federal decision, the following 10 species were reasonably expected to occur on soybean and cotton fields, which could potentially be treated with dicamba and therefore could not be assumed to be "no effect" solely on the basis of occurrence outside the action area:

- gray wolf (*Canis lupis*)
- Indiana bat (*Myotis sodalis*)
- Ozark bat (*Corynorhinus townsendii ingens*)
- Louisiana black bear (*Ursus americanus luteolus*)
- whooping crane (*Grus americana*)
- Mississippi sandhill crane (*Grus canadensis pulla*)
- lesser prairie-chicken (*Tympanuchus pallidicinctus*)
- gopher tortoise (*Gopherus polyphemus*)
- American burying beetle (*Nicrophorus americanus*)
- Spring Creek bladderpod (*Lesquerella perforata*)

Therefore, species specific biological information (e.g., body size, dietary requirements, and seasonality) and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations.

This assessment also uses the refined exposure values determined in the cotton screening level assessment and the concurrently issued addendum to the soybean screening level risk assessment documents compared to the initial exposure estimates from the soybean screening level assessment. This ESA assessment also evaluates chronic exposures from DCSA separately from the chronic exposure to parent

dicamba. Dicamba exposure values were determined from the upper bound of the modeled T-REX run for exposures following spray applications based on the Kenaga nomogram modified by Fletcher *et al* (1984), which is based on a large set of actual field residue data. Modeled dicamba exposure values were identical between the soybean addendum and the cotton screening level risk assessment (since the maximum application rates and minimum application intervals are the same).

Similar modeling of DCSA residues, which are formed inside the tolerant-soybean and tolerant-cotton plants through plant metabolism, is not feasible at this time due to a lack of sufficient data tracking DCSA residues in plant tissues over time to ascertain degradation rates. Therefore, in the soybean addendum and the cotton screening-level risk assessment, EFED used the maximum empirical measured DCSA residue concentrations in dicamba-tolerant soybean (61.1 mg/kg (ppm) DCSA in broadleaf plants and 0.440 ppm in soybean seeds) and cotton plant tissues (6.29 ppm DCSA in cotton gin byproducts and 0.27 ppm in undelinted cotton seed) to evaluate chronic exposures to DCSA for animals foraging on soybean and cotton plants. Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed soybean/cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications (*i.e.* arthropod concentrations estimated to be approximately 70% of the concentrations in broadleaf plant tissues or 42.5 ppm DCSA in arthropods feeding on soybean plants and 4.4 ppm in arthropods feeding on cotton plants). The empirical residue data for cotton indicated that chronic exposures of birds and mammals to dicamba or DCSA in cotton tissues *would not* be above any levels of concern. Although the concurrently issued soybean addendum indicates that chronic risk to mammals and birds was only a concern from DCSA residues in plant/prey tissues and not from residues of parent dicamba, since the original soybean screening-level assessment (USEPA, 2011) indicated chronic risk to mammals, this assessment presents the estimated exposures and comparisons to threshold toxicity values for both dicamba and DCSA for mammals, but evaluates them separately since their chronic toxicity and exposure profiles differ greatly. For birds, following the conclusions of the screening level assessments and the soybean addendum, only acute risk from dicamba exposures and chronic risk from DCSA exposures is evaluated.

Critical Habitat Analysis

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis (**Appendix 3**) consistent with the Overview Document (USEPA, 2004) as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species.

The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Refined ecological risk assessment for the remaining species potentially exposed to dicamba and DCSA residues

For the effects determinations for whooping crane, sandhill crane, lesser prairie chicken, gopher tortoise, American burying beetle, spring creek bladderpod, Indiana bat, Ozark bat, gray wolf and Louisiana bear,

a refined risk assessment approach was used to evaluate additional lines of evidence to determine whether the conservative generic assumptions in the screening risk assessment apply to a particular species of interest (*e.g.* the whooping crane). In the example of the whooping crane, the refined risk assessment investigated the impacts of more crane-specific data related to:

1. Bird size (as the crane is larger than the 1000g large bird category used in the initial screen)
2. Bird food consumption tailored to:
 - a. The true weight of the bird
 - b. Energy requirements of the crane
 - c. Improvement on the generic food intake model of the screen to assess energy content of the diet and the actual free living energy requirements of a bird the size of a crane
3. Toxicity endpoints were scaled from the weight of the tested surrogate species (bobwhite quail) to reflect the comparatively larger actual size of the whooping crane.

Using the whooping crane as the example to show how EPA made its effects determinations, EPA determined that the whooping crane could be feeding on arthropod prey in treated cotton and soybean fields during its migration from March to May. As stated above, for acute and chronic exposures to dicamba, EPA used the upper bound predicted concentrations of dicamba DGA salt found on arthropods from T-REX modeling. For chronic exposures to DCSA residues, EPA used the maximum measured concentrations found in broadleaf plants, modified by the Kenaga relationship between broadleaf plants and arthropods. This prey analysis is consistent with the preliminary risk concerns identified in the screening assessment. This analysis is conservative as it assumes 1) that 100% of the crane's food consumption comes from exposed arthropods and 2) the level of dicamba DGA residues assumed to be on these prey arthropods is based on the upper bound Kenaga residues expected for arthropods directly exposed to spray applications of dicamba DGA and for exposure to DCSA that residues in the arthropod prey item are based on the maximum measured values in broadleaf plant tissues modified by the Kenaga relationship between residues in arthropods and broadleaf plants following spray applications. EPA determined the field metabolic rate of the whooping crane through the use of a published peer reviewed allometric equation that relates bodyweight to energy requirements. From there the mass of prey consumed per day is determined by dividing the field metabolic rate (kcal/day) by the energy content of the arthropod prey and an assimilation factor that accounts for the ability of birds to absorb that energy from the diet. Values were obtained from a published peer reviewed EPA document produced by the Office of Research and Development for Agency-wide use in conducting ecological risk assessment (Wildlife Exposure Factors Handbook, USEPA, 1993). The mass of dicamba DGA in the insect diet is determined from the T-REX run found in the addendum to the soybean screening-level risk assessment (USEPA, 2016a), issued concurrently with this risk assessment while the mass of DCSA in insect diet was assumed to be 42.5 ppm (70% of the maximum measured residues in soybean hay of 61.1 ppm). The mass of prey consumed per day is then multiplied by the mass of dicamba or DCSA in the insect diet to determine the mass of dicamba or DCSA in the crane's daily diet in mg/day. Then the daily dose that the crane (considering its bodyweight) receives is determined by multiplying the mass of dicamba or DCSA in the daily diet of arthropods (assuming that is the only food item) times the mass of prey consumed per day divided by the bodyweight of the crane. Then EPA scaled the acute toxicity endpoint (based on the most sensitive tested surrogate bird species, bobwhite quail's default weight of 178 grams) to the bodyweight of the whooping crane to determine the acute oral toxicity for the crane. For exposures to

DCSA residues, the chronic toxicity endpoint for the mallard (the most sensitive tested species) was modified by the relationship between the chronic dicamba and DCSA endpoints for rats (a 17x difference). The acute RQ for dicamba exposures is then calculated by dividing the daily dose of dicamba from consuming arthropods by the acute oral toxicity endpoint while the chronic RQ is calculated by dividing the daily dose of DCSA by the chronic toxicity endpoint. In this case the acute RQ for dicamba was 0.03, which is below the endangered species level of concern of 0.1, while the chronic RQ for DCSA was 0.11, which is below the listed and non-listed species chronic LOC of 1.0. At this point, EPA was able to conclude that dicamba and its metabolite DCSA would not have a direct effect on the whooping crane.

Birds

The screening-level assessments showed that birds could be at risk of mortality from acute exposures to dicamba DGA on treated fields, but chronic risk to dicamba was not expected as no chronic RQs exceeded the Agency's LOC (1.0) for chronic risk (USEPA 2011. D378444, p. 15). The concurrently issued soybean addendum did indicate that chronic exposures to DCSA residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, for listed species that could reasonably be expected to occur on treated soybean and cotton fields, EPA conducted a refined assessment for acute (dicamba only) and chronic (DCSA only, and only for soybean) exposures. Of the bird species identified as potentially at acute risk in the sixteen states, three are reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

Whooping crane

Dicamba Acute Effects Assessment

Whooping cranes migrate from Texas to Canada from March 25th to May 1st (Canadian Wildlife Service and USFWS, 2007). Whooping cranes are omnivorous and during migration may feed on a variety of foods including frogs, fish, plant tubers, crayfish, insects and agricultural grains. EFED considered the upper bound T-REX predicted concentrations of DGA expected to be found on arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as modeled residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. Alternative terrestrial vertebrate prey and agricultural grains are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(5826)^{0.749} = 757.6$ kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = $757.6 \text{ kcal/day} / (1.7 \text{ kcal/g} \times 0.72 \text{ AE}) = 619$ g/day

Mass of DGA in insect diet 102.99 mg/kg-bw from T-REX run

Mass of DGA in daily diet mg = 619 g/day X 102.99 mg DGA/kg bird prey X 0.001 = 63.75 mg/day

Daily dose in crane = 63.75 mg DGA/day/5.826 kg = **10.94 mg/kg-bw/day**

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the crane is:

Crane LD50 mg/kg-bw = 188 mg/kg-bw (5826/178)^(1.15-1) = **317.25mg/kg-bw**

RQ for daily acute exposure for three applications, peak exposure number: RQ = 10.94/317.25 = **0.03**.

An RQ of 0.03 does not exceed the acute LOC of 0.1; **consequently a “no effect” determination is concluded for the whooping crane.**

DCSA Assessment for Whooping Crane consuming prey that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. Alternative terrestrial vertebrate prey and agricultural grains are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = 1.146(5826)^{0.749} = 757.6 kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = 757.6 kcal/day/(1.7 kcal/gX0.72 AE) = 619 g/day

Mass of DCSA in insect diet 42.5 mg/kg-bw (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet mg = 619 g/day X 42.5 mg DCSA/kg bird prey X 0.001 = 26.31 mg/day

Daily dose in crane = 26.31 mg DCSA/day/5.826 kg = **4.52 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: RQ = 4.52/40.88 = **0.11**

An RQ of 0.11 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the whooping crane.**

Mississippi sandhill crane

Sandhill cranes are known to feed on farms nearby the Mississippi Sandhill Crane National Wildlife Refuge that they inhabit (USFWS, 1991). Cranes feed on adult and larval insects, earthworms, crayfish, small reptiles, amphibians, roots, tubers, seeds, nuts, fruits and leaves. EFED considered the upper bound T-REX predicted concentrations of DGA expected to be found on arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as modeled residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. Alternative terrestrial vertebrate prey are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(2500)^{0.749} = 402.01$ kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = $402.01 \text{ kcal/day} / (1.7 \text{ kcal/g} \times 0.72 \text{ AE}) = 328.44 \text{ g/day}$

Mass of DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet mg = $328.44 \text{ g/day} \times 102.99 \text{ mg DGA/kg bird prey} \times 0.001 = 33.82 \text{ mg/day}$

Daily dose in crane = $33.82 \text{ mg DGA/day} / 2.5 \text{ kg} = 13.53 \text{ mg/kg-bw/day}$

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the crane is:

Crane LD50 mg/kg-bw = $188 \text{ mg/kg-bw} (2500/178)^{(1.15-1)} = 279.44 \text{ mg/kg-bw}$

RQ for daily acute exposure for three applications, peak exposure number: $RQ = 13.53/279.44 = 0.05$.

An RQ of 0.05 is less than the acute LOC of 0.1; **consequently a “no effect” determination is concluded for the Mississippi sandhill crane.**

DCSA Assessment for Mississippi sandhill crane consuming prey that had previously fed on soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the crane's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants

that had the highest measured DCSA residues. Alternative terrestrial vertebrate prey and agricultural grains are expected to have lower residues than those predicted for arthropods. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(2500)^{0.749} = 402.01$ kcal/day (USEPA 1993, body weight Dunning 1984)

Mass of prey consumed per day = $402.01 \text{ kcal/day} / (1.7 \text{ kcal/g} \times 0.72 \text{ AE}) = 328.44 \text{ g/day}$

Mass of DCSA in insect diet 42.5 mg/kg-bw (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet mg = $328.44 \text{ g/day} \times 42.5 \text{ mg DCSA/kg bird prey} \times 0.001 = 13.96 \text{ mg/day}$

Daily dose in crane = $13.96 \text{ mg DGA/day} / 2.5 \text{ kg} = 5.58 \text{ mg/kg-bw/day}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $= 5.58 / 40.88 = 0.14$.

An RQ of 0.14 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Mississippi sandhill crane**

Lesser prairie chicken

The lesser prairie chicken makes use of agricultural fields at specific times of the year. However, as explained below, all available lines of evidence indicate the use of cotton and soybean fields is limited temporally and that the agricultural field is not an ideal habitat for the species because conversion of rangelands to cropland has reduced lesser prairie-chicken populations greatly since the early 1900's (Giesen 1998). An analysis of exposure potential for dicamba DGA use and lesser prairie chickens focused on the seasonal use of soybean and cotton fields by the birds as well as the likely food consumption during those periods.

Available information suggests that the birds do not use agricultural fields during the nesting and rearing cycle. Nesting lesser prairie chickens have been observed to establish nest sites deep within native prairie habitat and similar grass land that affords adequate cover and an understory that allows the young to move. Within these areas, nesting sites are observed to be situated far from edge areas (Jamison, 2000 and Hagen et al. 2007). A review of nesting and brood rearing habitat studies indicates that hens nest in tall, residual grasses or under shrubs in native pasture avoiding shortgrass habitats and cultivated fields and transition to habitats for rearing brood that can be described as areas with abundant bare ground and approximately 25% canopy cover of shrubs, forbs, or grasses <30 cm in height (Jamison, 2000). In Jamison's review of almost a dozen studies of nesting and brood rearing habitat, cotton and soy fields are not included as habitat used by the birds. Similarly, spring and summer foraging habitat has been

summarized as including grasses and forbs less than 80 cm in height (Jamison, 2000). In all studies of spring and summer habitat there is no inclusion of cotton or soybean as a cover type utilized by the birds during nesting, brood rearing or foraging.

In contrast to the spring and summer months, the lesser prairie chicken in Finney County of southwestern Kansas has been observed commonly foraging in agricultural fields such as harvested fields of irrigated corn during fall and winter (Jamison, 2000) and this pattern has been confirmed by a radiotelemetry study (Salter et al. 2005). Rob and Schroeder (2005) report similar use of soybean fields by the birds as a fall and winter source of seed and Jamison (2000) cited 17 studies reporting the use of sorghum, corn and other grain fields as fall and winter foraging habitat in areas adjacent to prairie chicken grassland habitat. This utilization of cropland during the fall and winter months for the present waste grain is further supported by Jamison et al. (2002) in their review of 25 habitat studies for the lesser prairie chicken (summarized in **Appendix 5**). Despite cropland comprising a cover type in many of these studies, observations of its actual use are confined to the fall and winter months and consumption of waste grain. The available information indicates that the lesser prairie chicken is attracted to corn and soybean fields in the fall and winter months, where the birds exploit waste seed as an important over-wintering food source.

Based on the reports of over two dozen studies spanning multiple sites across the lesser prairie chicken established range, it is reasonable to expect that utilization of cotton and soybean by lesser prairie chickens occurs during the fall and winter months and is associated with the consumption of waste grain and seed in the fields. However, it is unlikely, given the toxic gossypol content of cotton seed, that the plant provides similar resources as corn and soybean for the bird. This is supported by the position of Timmer (2012) which states that cotton is not considered habitat for this species. Consequently, the exposure refinement for the labeled dicamba DGA product use on soybean and cotton should focus on the consumption of soybean seeds. This may still be considered conservative as 100% of the chicken's diet would be considered to consist of exposed seed receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(730)^{0.749} = 159.89$ kcal/day (USEPA 1993, body weight The Birds of North America, No. 364, 1998)

Mass of seed consumed per day = $159.89 \text{ kcal/day} / (4.6 \text{ kcal/g} \times 0.59 \text{ AE}) = 58.91 \text{ g/day}$

Mass of DGA in seed diet 16.43 mg/kg-ww from T-REX run

Mass of DGA in daily diet mg = $58.91 \text{ g/day} \times 16.43 \text{ mg DGA/kg bird prey} \times 0.001 = 0.97 \text{ mg/day}$

Daily dose in chicken = $0.97 \text{ mg DGA/day} / 0.73 \text{ kg} = \mathbf{1.33 \text{ mg/kg-bw/day}}$

Scaling the acute toxicity endpoint by bodyweight (per T-REX methodology), the acute oral toxicity value for the chicken is:

Chicken LD50 mg/kg-bw = $188 \text{ mg/kg-bw} (737/178)^{(1.15-1)} = \mathbf{232.32 \text{ mg/kg-bw}}$

RQ for daily acute exposure for three applications, peak exposure number: $RQ = 1.33/232.66 = 0.01$.

An RQ of 0.01 does not exceed the acute LOC of 0.1; **consequently EPA makes a “no effect” determination for the lesser prairie chicken.**

DCSA Assessment for lesser prairie chicken consuming soybean seeds

As above, the exposure for DCSA residues in soybean and cotton should focus on the consumption of soybean seeds. This may still be considered conservative as 100% of the chicken’s diet would be considered to consist of exposed seed receiving maximum measured residues in soybean seed. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(730)^{0.749} = 159.89$ kcal/day (USEPA 1993, body weight The Birds of North America, No. 364, 1998)

Mass of seed consumed per day = $159.89 \text{ kcal/day} / (4.6 \text{ kcal/g} \times 0.59 \text{ AE}) = 58.91 \text{ g/day}$

Mass of DCSA in seed diet 0.44 mg/kg-ww (max residues from empirical data on dicamba-tolerant soybean seed).

Mass of DCSA in daily diet mg = $58.91 \text{ g/day} \times 0.44 \text{ mg DCSA/kg bird prey} \times 0.001 = 0.026 \text{ mg/day}$

Daily dose in chicken = $0.026 \text{ mg DCSA/day} / 0.73 \text{ kg} = 0.036 \text{ mg/kg-bw/day}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (34x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure for three applications, peak exposure number: $RQ = 0.036/40.88 = <0.01$.

An RQ of <0.01 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the lesser prairie chicken.**

Reptiles and amphibians

Using birds as a surrogate for reptiles and terrestrial-phase amphibians, consistent with the Overview document (USEPA, 2004), the screening level assessment suggests that reptiles and terrestrial-phase amphibians could be at risk of effects from acute exposures to dicamba DGA or chronic exposures to DCSA on treated fields. Of the reptile and amphibian species identified as potentially at risk in the sixteen states, one reptile is reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for that species.

Gopher tortoise

The gopher tortoise inhabits droughty, deep sand ridges, xeric communities, originally longleaf pine-scrub oak, and may also be found along fence rows, field edges, power lines, and in pastures (USFWS, 1990). The tortoise feeds on plant material, such as leaves and grass. EFED considers the maximum T-REX predicted concentrations of DGA expected to be found on short grass as a conservative pesticide load in the dietary items. This is considered conservative as it assumes 100% of the tortoise's diet is exposed short grass (for which modeled T-REX residues are higher than any other dietary item) receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

$$\text{Field metabolic rate kcal/day} = 0.019(4500)^{0.841} = 22.44 \text{ kcal/day (USEPA 1993)}$$

$$\text{Mass of soybean plants consumed per day} = 22.44 \text{ kcal/day} / (1.3 \text{ kcal/g} \times 0.47 \text{ AE}) = 36.73 \text{ g/day}$$

$$\text{Mass of DGA in short grass diet} = 262.94 \text{ mg/kg-ww from T-REX run}$$

$$\text{Mass of DGA in daily diet mg} = 36.73 \text{ g/day} \times 262.94 \text{ mg DGA/kg tortoise prey} \times 0.001 = 9.66 \text{ mg/day}$$

$$\text{Daily dose in tortoise} = 9.66 \text{ mg DGA/day} / 4.5 \text{ kg} = \mathbf{2.15 \text{ mg/kg-bw/day}}$$

Appropriate scaling factors are not available for reptiles and amphibians so the acute toxicity value for the bobwhite quail (most sensitive avian species for which acute data are available) serves as a surrogate (USEPA, 2004) toxicity value for the tortoise:

$$\text{Tortoise LD50 mg/kg-bw} = \mathbf{188 \text{ mg/kg-bw}}$$

$$\text{RQ for daily acute exposure for three applications, peak exposure number: } \text{RQ} = 2.15 / 188 = \mathbf{0.01}.$$

An RQ of 0.01 less than the acute LOC of 0.1; **consequently a “no effect” determination is concluded for the gopher tortoise.**

DCSA Assessment for gopher tortoise consuming soybean forage

As above, the tortoise feeds on plant material, such as leaves and grass. EFED considers the maximum measured DCSA residues in soybean tissue as a conservative pesticide load in the dietary items. This is considered conservative as it assumes 100% of the tortoise's diet is exposed soybean leaves/stems, which would have the highest DCSA residues. A biologically representative refinement to the screening assessment follows:

$$\text{Field metabolic rate kcal/day} = 0.019(4500)^{0.841} = 22.44 \text{ kcal/day (USEPA 1993)}$$

$$\text{Mass of soybean plants consumed per day} = 22.44 \text{ kcal/day} / (0.63 \text{ kcal/g} \times 0.47 \text{ AE}) = 75.79 \text{ g/day}$$

$$\text{Mass of DCSA in soybean forage (broadleaf plant) diet} = 61.1 \text{ mg/kg-ww from max residues from empirical data on dicamba-tolerant soybean forage}$$

Mass of DCSA in daily diet mg = 75.79 g/day X 61.1 mg DCSA/kg tortoise prey X 0.001 = 4.63 mg/day

Daily dose in tortoise = 4.63 mg DCSA/day/4.5 kg = **1.03 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck (surrogate for reptiles) for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (34x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 1.03/40.88 = 0.03$.

An RQ of 0.03 less than the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the gopher tortoise.**

Terrestrial Invertebrates

The screening-level risk assessments (USEPA, 2011 D378444 and USEPA, 2016b D404823) did not identify risk concerns for terrestrial invertebrates. Additional analyses in the first addendum to the soybean assessment (USEPA, 2014. D404138+) and the subsequent addendum issued concurrently with this ESA assessment (USEPA, 2016a) indicate that using a screening approach and given the available empirical toxicological data for terrestrial invertebrates showing that dicamba is practically non-toxic to honey bees, acute contact (from exposure to direct sprays of dicamba) and acute dietary (from exposure to dicamba residues in pollen and nectar) risks are not anticipated (*i.e.* acute oral and dietary exposures were below LOCs) to arthropods under the proposed use patterns for dicamba on tolerant soybean and cotton. Though the chronic toxicity of dicamba to adult and larval honey bees is more uncertain, EPA’s analysis from the concurrent soybean addendum and cotton assessment using chronic data for other invertebrates (*i.e.* daphnids) also indicates that chronic toxicity to honey bees and other terrestrial invertebrates is anticipated to be low. No other data has been submitted to the Agency for dicamba’s toxicity to other arthropods.

No data is available for the acute or chronic toxicity of dicamba’s degradate DCSA to honey bees or other pollinators. Although EFED used the toxicity differential between the chronic mammalian studies with dicamba and DCSA to estimate a chronic endpoint for avian organisms, such an approach is not considered appropriate for terrestrial organisms given the greater differences in species biology between arthropod taxa compared to birds and mammals. However, based on the available data including the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

Despite the addendum and screening-level conclusions that direct risk from dicamba DGA to terrestrial invertebrates is not anticipated, EPA investigated whether there were any arthropod species on treated soybean and cotton fields that might be indirectly impacted by the effect of dicamba on plants on the treated field. One arthropod is reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific habitat information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for that species.

American burying beetle

Habitat use and dependencies were explored to determine if any effects on plants would indirectly affect the burying beetle. Except where noted, the information was sourced from the Recovery Plan for the species (USFWS, 1991). The American burying beetle is a carnivorous species. Adults feed on a variety of carrion as well as live insects. The larvae are reared on cached (buried) carrion. Consequently, any effect of dicamba DGA would be mediated through the availability of vegetative cover for the species because direct toxic effects are not expected, and plants do not constitute a necessary food component. Variable habitat and wide soil types make its habitat difficult to describe in anything other than broad terms.

The species exhibits broad vegetation tolerances (from large mowed and grazed fields to dense shrub thickets), though natural habitat may be mature forests. The species has been recorded in grassland, old field shrubland, and hardwood forests. For example, the Block Island population (Rhode Island) occurs on glacial moraine dominated by maritime scrub-shrub community. Plant species include bayberry, shadbush, goldenrod, and various non-native plants. Oklahoma habitats vary from deciduous oak-hickory and coniferous forests atop ridges or hillsides to deciduous riparian corridors and pasturelands on valley floors.

Based on the available data, there are no direct toxicological effects to the burying beetle. Likely, the only potential mechanism for an indirect effect from dicamba would be a reduction in cover provided by plants. The Recovery Plan (USFWS 1991) indicates that vegetative structure and soil types are unlikely to be limiting factors for the burying beetle given its broad historical geographic range. Furthermore, the apparent persistence of the beetle on Block Island suggests broad vegetation (landscape) tolerances. Given that applications of dicamba DGA will occur when the crop is intact, the field is expected to maintain sufficient vegetative cover for the burying beetle. **Consequently, a “no effect” determination is concluded for the American burying beetle.**

Terrestrial Plants

The screening level risk assessment showed that dicot plant species, but not monocots, would be at risk of adverse effects from dicamba applications. Of the terrestrial plant species identified as potentially at risk in the sixteen states, one plant species is reasonably expected to occur on treated soybean and cotton fields.

Spring Creek Bladderpod

Dicamba is highly toxic to broadleaf plant species (most sensitive NOAEC of 0.000261 lbs a.i./A for non-tolerant soybean) and given a maximum single application rate of 1.0 lbs a.i./A, it is assumed that any dicots on the field at the time of application would be considered to be at risk. The Spring Creek bladderpod (a dicot in the Brassicaceae family), is found in northern Wilson County, Tennessee in the watersheds of Spring Creek, Bartons Creek, and Cedar Creek. It is located primarily in the floodplain, in agricultural fields, as well as pastures, glades, and disturbed areas. It is found mainly on newly disturbed sites and requires some degree of annual disturbance to complete its lifecycle (USFWS 2006).

This species is a winter annual that “germinates between September and early October, overwinters as a small rosette of leaves, and fully develops and flowers the following spring. Full sun is required for

optimum growth. Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn,” when the cycle starts over again (USFWS, 2006). “If conditions are not suitable for germination the following fall, the seeds can remain dormant (but viable) for several years” (USFWS 1996).

It is likely that the species is in flowering stage when dicamba DGA is applied to soybean and cotton fields in the early season. **Consequently, EPA makes a “may effect, likely to adversely affect” determination for the Spring Creek bladderpod.**

Mammals

The screening-level assessments indicated that acute risk to mammals was not expected as no acute RQs exceeded the Agency’s LOC (0.1) for acute risk (USEPA 2011. D378444, p. 15). However, the soybean screening-level assessment (USEPA, 2011) indicated that mammals could be at reproductive risk from chronic exposures to dicamba DGA on treated fields, though the cotton screening level and concurrently issued soybean addendum (USEPA, 2016a and USEPA, 2016b) indicated that chronic exposures to dicamba DGA would be below the chronic LOC (1.0). This difference is due to soybean screening level risk assessment’s use of a chronic endpoint from the rat 2-generation study (MRID 43137101), of 45 mg/kg-bw for the NOAEL, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016c; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, as pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. Therefore, the cotton screening level risk assessment, the concurrently issued soybean addendum and this refined endangered species risk assessment use this revised NOAEL for dicamba DGA salt.

The concurrently issued soybean addendum did indicate that chronic exposures to dicamba’s metabolite, DCSA, residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency’s LOC for chronic risk. Therefore, EPA only conducted a refined assessment for chronic exposures to DCSA in soybeans for listed species that could reasonably be expected to occur on treated soybean fields.

Of the mammalian species identified as potentially at risk in the sixteen states, four are reasonably expected to occur on treated soybean fields. Species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for the four species potentially expected to occur on treated soybean fields.

Gray Wolf

According the USFWS Recovery Plan (USFWS 1982), gray wolves are habitat generalists that live throughout the northern hemisphere. Gray wolves are a carnivorous species that typically feed on ungulate species, such as deer. While not likely to feed on agricultural fields themselves, the primary prey species of the gray wolf may be expected to feed on plant material within the field during the period of applications. Based on this information, it is reasonable to conclude that the gray wolf may be exposed to dicamba DGA residues in prey. A biologically representative modification to the screening assessment

follows:

The first step in the refinement process is to calculate dicamba DGA residues in the prey species. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

$$1000 \text{ g mammal prey ingestion rate (dry)} = 0.621(1000)^{0.564} = 30.56 \text{ g /day}$$

$$1000 \text{ g mammal prey ingestion rate (wet)} = 30.56/0.2 = 152.8 \text{ g/day}$$

$$\text{Dicamba DGA residue in prey eating short grass from T-REX} = 262.94 \text{ mg dicamba DGA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{40.17 \text{ mg/kg-bw/day}}$$

The next step is to calculate the expected daily dose for a typical 17.7 kg (17700 g) gray wolf, the adjusted NOAEL value and the chronic dose-based RQ for the gray wolf based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.235(17700)^{0.822})/(1-0.69)/1000 = 2.35 \text{ kg wet/day}$$

$$\text{Dose-based EEC in wolf eating small mammal} = 40.17 \text{ mg/kg wet} \times 2.35/(17700/1000) = \mathbf{5.33 \text{ mg/kg-bw/day}}$$

$$\text{Adjusted NOAEL} = 136 \text{ mg/kg-bw } (350/17700)^{(0.25)} = \mathbf{51.00 \text{ mg/kw-bw}}$$

$$\text{Chronic Dose-Based RQ} = 5.33/51.00 = \mathbf{0.10}$$

An RQ of 0.10 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Gray Wolf.**

DCSA Assessment for Gray Wolf consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

$$1000 \text{ g mammal prey ingestion rate (dry)} = 0.621(1000)^{0.564} = 30.56 \text{ g /day}$$

$$1000 \text{ g mammal prey ingestion rate (wet)} = 30.56/0.2 = 152.8 \text{ g/day}$$

$$\text{DCSA residue in prey eating soybean forage/hay} = 61.1 \text{ mg DCSA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{9.34 \text{ mg/kg-bw/day}}$$

The next step is to calculate the expected daily dose for a typical 17.7 kg (17700 g) gray wolf, the adjusted NOAEL value and the chronic dose-based RQ for the gray wolf based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.235(17700)^{0.822})/(1-0.69)/1000 = 2.35 \text{ kg wet/day}$$

Dose-based EEC in wolf eating small mammal = $9.47 \text{ mg/kg wet} \times 2.35 / (17700 / 1000) = \mathbf{1.24 \text{ mg/kg-bw/day}}$

Adjusted NOAEL = $8 \text{ mg/kg-bw} (350 / 17700)^{(0.25)} = \mathbf{3.00 \text{ mg/kg-bw}}$

Chronic Dose-Based RQ = $1.25 / 3.00 = \mathbf{0.41}$

An RQ of 0.41 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Gray Wolf.**

Indiana Bat

The USFWS Recovery Plan (USFWS 2007) states that most Indiana bat maternity colonies have been found in agricultural areas with fragmented forests. According to the Recovery Plan there are some 235,000 individual bats within the hibernacula of the states subject to the proposed Federal action. The Recovery Plan also indicates that the sex ratio of males to females is roughly equal. Therefore, there are approximately 117,500 female bats within the hibernacula that are found in the states in this proposed Federal action.

While bats may be associated with forested areas proximal to agricultural land, data on the extent and possibility of foraging over agricultural fields is limited. The Recovery Plan states that observations of light-tagged animals and bats marked with reflective bands indicate that Indiana bats typically forage in closed to semi-open forested habitats and forest edges and that radio-tracking studies of adult males, adult females, and juveniles consistently indicate that foraging occurs preferentially in wooded areas, although type of forest varies with individual studies. The Recovery Plan states that Indiana bats hunt primarily around, not within, the canopy of trees, but they occasionally descend to sub-canopy and shrub layers. However, the Recovery Plan also states that Indiana bats have been caught, observed, and radio-tracked foraging in open habitats; analyses of habitats used by radio-tracked adult females while foraging versus those habitats available for foraging have been performed in two states.

In Illinois, floodplain forest was the most preferred habitat, followed by ponds, old fields, row crops, upland woods, and pastures. In Indiana, woodlands were used more often than areas of agriculture, low-density residential housing, and open water, and this latter group of habitats was used more than pastures, parkland, and heavily urbanized sites. Old fields and agricultural areas seemed important in both studies, but bats likely were foraging most often along forest-field edges, rather than in the interior of fields, although errors inherent in determining the position of a rapidly moving animal through telemetry made it impossible to verify this. The Recovery Plan remarks that visual observations suggest that foraging over open fields or bodies of water, more than 50 m (150 ft) from a forest edge, does occur, although less commonly than in forested sites or along edges. The Recovery Plan places feeding within agriculturally managed areas of lesser significance than forested areas and their immediate edges.

The Recovery Plan reports that in Illinois, 67 percent of the land near one colony was agricultural, and in Michigan, land cover consisted of 55 percent agricultural land. Recovery Plan discussion of available proportions of different land covers encompassing foraging habitat are limited, but the available literature suggests that foraging in agricultural lands relative to other habitats is variable with study. Sparks et al. (2005), in radio-tracking bats in Indiana, found that the number of telemetry observations of foraging was closely associated with the availability of agricultural land within the home range of the species and accounted for approximately 35 percent of observations. In contrast, Murray and Kurta (2004) radio-

tracked Indiana bats in Michigan and found that, despite the study area being over 60 percent agricultural land, the habitats frequented by 12 of the 13 monitored bats was forest land. It should be noted that exact frequencies could not be established because triangulation of individual observation points precluded exact locations in different cover types with any confidence. Menzel et al. (2005) radio-tracked bats in Illinois and found that bats foraged significantly closer to forest roads and riparian habitats than agricultural lands. A ranking of the foraging use of habitats suggested the following order of preference by bats in this study: roads> forests> riparian areas> grasslands>agricultural lands.

The Recovery Plan indicates that the prey base for the Indiana bat consists primarily of flying insects, with only a very small amount of spiders (presumably ballooning individuals) included in the diet. Four orders of insects contribute most to the diet: Coleoptera, Diptera, Lepidoptera, and Trichoptera. The Recovery Plan concludes that the diet of Indiana bats, to a large degree, may reflect availability of preferred types of insects within the foraging areas that the bats happen to be using, again suggesting that they are selective opportunists.

Given the above information, it is reasonable to conclude that Indiana bats make use of agricultural land as a source of prey and can reasonably be expected to roost in patches of fragmented forest that are adjacent to cotton and soybean fields. They are opportunistic foragers and are expected to forage over many different land covers, including agricultural land, on a broad range of insects/arthropods. A survey of insect populations in agricultural fields reveals a variety of flying, foliage and ground dwelling invertebrates comprising a large number of taxonomic groups that could provide on-field prey sources for bats foraging over these areas. However, the extent of foraging over agricultural land is expected to be less than the degree of foraging around the canopies of forested areas.

Initial screening level risk assessment results for the Indiana bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods having received the upper bound Kenaga residues from the spray application of dicamba.

Field metabolic rate kcal/day = $0.6167(5.4)^{0.862} = 2.64$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Indiana bat)

Mass of prey consumed per day = 2.64 kcal/day / (1.7 kcal/g ww X 0.87AE) = 1.78 g/day

Mass of DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet = 1.78 g/day X 102.99 mg DGA/kg-ww mammal prey X 0.001 = 0.18 mg/day

Daily dose in bat = 0.18 mg DGA/day/0.0054 = **33.95 mg/kg-bw/day**

Indiana Bat NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw } (350/5.4)^{(0.25)} = 385.88 \text{ mg/kg-bw}$
 RQ for chronic exposure for three applications, peak exposure number: $RQ = 33.95/385.88 = 0.09$.

An RQ of 0.09 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Indiana Bat.**

DCSA Assessment for Indiana bat consuming prey that had previously consumed soybean forage

Initial screening level risk assessment results for the Indiana bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods feeding on dicamba-tolerant soybean plant tissues that had the highest measured DCSA residues.

Field metabolic rate kcal/day = $0.6167(5.4)^{0.862} = 2.64$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Indiana bat)

Mass of prey consumed per day = $2.64 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.87\text{AE}) = 1.78 \text{ g/day}$

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = $1.78 \text{ g/day} \times 42.5 \text{ mg DCSA/kg-ww insect prey} \times 0.001 = 0.076 \text{ mg/day}$

Daily dose in bat = $0.076 \text{ mg DCSA /day} / 0.0054 \text{ kg} = \mathbf{14.01 \text{ mg/kg-bw/day}}$

Indiana Bat NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} (350/5.4)^{(0.25)} = \mathbf{22.70 \text{ mg/kg-bw}}$

RQ for chronic exposure: $\text{RQ} = 8.00/22.70 = \mathbf{0.62}$

An RQ of **0.62** does not exceeds the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Indiana Bat.**

Ozark Bat

The Ozark big-eared bat inhabits caves and cliffs that can be found in large blocks of forest to small forest tracts interspersed with open areas. Land use of surrounding areas does not appear to influence location of occupied maternity caves and hibernacula. The Recovery Plan (USFWS, 1995) indicates that the prey base for the Ozark bat consists primarily of lepidopterans and that edge habitat between forested and open areas is the preferred foraging area. Open areas allow for easy foraging because bats are not obstructed by branches while pursuing prey and are able to discriminate insects at greater distances. Based on this information, the Ozark bat cannot be precluded from foraging on agricultural fields.

Initial screening level risk assessment results for the Ozark bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects having received the upper bound Kenaga residues from the spray application of dicamba.

Field metabolic rate kcal/day = $0.6167(7.0)^{0.862} = 3.30$ kcal/day (USEPA 1993, body weight reflects screening assumption for the Ozark bat)

Mass of prey consumed per day = $3.30 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.87\text{AE}) = 2.23 \text{ g/day}$

Mass of DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet = 2.23 g/day X 102.99 mg DGA/kg-ww mammal prey X 0.001 = 0.23 mg/day

Daily dose in bat = 0.23 mg DGA/day/0.007 = **32.81 mg/kg-bw/day**

Ozark Bat NOAEL mg/kg-bw/day = 136 mg/kg-bw (350/7.0)^(0.25) = **361.64 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: RQ = 32.81/361.64 = **0.09**.

An RQ of 0.09 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Ozark Bat.**

DCSA Assessment for Ozark Bat consuming prey that had previously consumed soybean forage

Initial screening level risk assessment results for the Ozark bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods feeding on dicamba-tolerant soybean plant tissues that had the highest measured DCSA residues.

Field metabolic rate kcal/day = 0.6167(7.0)^{0.862} = 3.30kcal/day (USEPA 1993, body weight reflects screening assumption for the Ozark bat)

Mass of prey consumed per day = 3.30 kcal/day / (1.7 kcal/g ww X 0.87AE) = 2.23 g/day

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 2.23 g/day X 42.5 mg DCSA/kg-ww mammal prey X 0.001 = 0.095 mg/day

Daily dose in bat = 0.095 mg DCSA/day/0.007 = **13.54 mg/kg-bw/day**

Ozark Bat NOAEL mg/kg-bw/day = 8 mg/kg-bw (350/7.0)^(0.25) = **21.27 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: RQ = 13.54/21.27 = **0.64**

An RQ of **0.64** does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Ozark Bat.**

Louisiana Black Bear

The Louisiana black bear inhabits bottomland hardwood forest communities, brackish and freshwater marshes, salt domes, wooded spoil levees along canals and bayous, and agricultural fields. Remoteness is an important spatial feature based on forest tract size and presence of roads (US FWS Recovery Plan, 1995). The Recovery Plan further describes black bears as opportunistic omnivores with their diet being

determined by food availability and season. Diet includes: grasses, sedges, invertebrates (primarily beetles, grubs, and insects), carrion, garbage, and agricultural crops (including grain from soybean and corn, but consumption of cotton plant parts is unlikely). Personal communication with Deborah Fuller of the USFWS (Fuller 2015) indicates that, by analogy to North Carolina black bears, Louisiana black bears can be expected to feed on cotton boll pests as well as grubs in the fields. The other potential attractive food source in these fields would be soybean grain. On the basis of this information and the expectation that the modeled residues on arthropods (111.14 mg dicamba DGA/kg) would be much higher than modeled residues in soybean pods or seeds (17.74 mg dicamba DGA/kg), a refinement of the screening level assessment for the bear was initiated to reflect the conservative assumptions of exclusive consumption of exposed terrestrial invertebrates having received the upper bound Kenaga residues from the dicamba application in a treated field:

Field metabolic rate kcal/day = $0.800(92000)^{0.813}$ = 8682.59 kcal/day (USEPA 1993, body weight reflects screening assumption for the Louisiana black bear)

Mass of prey consumed per day = 8682.59 kcal/day / (1.7 kcal/g ww X 0.87 AE) = 5870.58 g/day

Mass of DGA in terrestrial invertebrate diet 102.99 mg/kg-ww from T-REX run

Mass of DGA in daily diet = 5870.58 g/day X 102.99 mg DGA/kg-ww mammal prey X 0.001 = 604.61 mg/day

Daily dose in bear = 604.61 mg DGA/day/92 kg = **6.57 mg/kg-bw/day**

Louisiana Black Bear NOAEL mg/kg-bw/day = 136 mg/kg-bw $(350/92000)^{(0.25)}$ = **33.78 mg/kg-bw**

RQ for chronic exposure for three applications, peak exposure number: $RQ = 6.57/33.78 = 0.19$.

A chronic RQ of 0.19 does not exceed the chronic LOC of 1.0. **Consequently a “no effect” determination is concluded for the Louisiana black bear.**

DCSA Assessment for Louisiana Black Bear consuming prey that had previously consumed soybean forage

The screening level risk assessment found that DCSA residues in arthropods in cotton fields (based on the empirical residues in broadleaf plant tissues and extrapolated via the Kenaga nomogram to residues in arthropods) would not exceed any chronic levels of concern for mammals. The analysis of the Louisiana Black Bear’s recovery plan described above indicates that in soybean fields, the attractive food source in these fields would be soybean grain (seeds). On the basis of this information, the refinement of the soybean screening level assessment was initiated to reflect the conservative assumption of exclusive consumption of exposed soybean grain containing the maximum measured DCSA residues.

Field metabolic rate kcal/day = $0.800(92000)^{0.813}$ = 8682.59 kcal/day (USEPA 1993, body weight reflects screening assumption for the Louisiana black bear)

Mass of soybean seeds consumed per day = $8682.59 \text{ kcal/day} / (0.51 \text{ kcal/g ww} \times 0.85 \text{ AE} 0.43) = 20029.0 \text{ g/day}$

Mass of DCSA in seed diet 0.440 mg/kg-ww (conservative assumption using the maximum value from empirical data for soybean seeds)

Mass of DCSA in daily diet = $20029 \text{ g/day} \times 0.44 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 8.88 \text{ mg/day}$

Daily dose in bear = $8.8 \text{ mg DCSA/day} / 92 \text{ kg} = \mathbf{0.10 \text{ mg/kg-bw/day}}$

Louisiana Black Bear NOAEL $\text{mg/kg-bw/day} = 8 \text{ mg/kg-bw} (350/92000)^{(0.25)} = \mathbf{1.99 \text{ mg/kg-bw}}$

RQ for chronic exposure for three applications, peak exposure number: $\text{RQ} = 0.10/1.99 = \mathbf{0.05}$

A chronic RQ of **0.05** does not exceed the chronic LOC of 1.0. **Consequently a “no effect” determination is concluded for the Louisiana black bear.**

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Appendix 1

Threatened and Endangered Species in Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin.

Animals

1. Acornshell, southern (*Epioblasma othcaloogensis*)
2. Amphipod, Illinois cave (*Gammarus acherondytes*)
3. Bat, gray (*Myotis grisescens*)
4. Bat, Indiana (*Myotis sodalis*)
5. Bat, Ozark Big-Eared (*Corynorhinus (=plecotus) townsendii ingens*)
6. Bean, Cumberland (pearlymussel) Populations (*Villosa trabalis*)
7. Bean, purple (*Villosa perpurpurea*)
8. Bean, rayed (*Villosa fabalis*)
9. Bear, Louisiana Black (*Ursus americanus luteolus*)
10. Beetle, American Burying (*Nicrophorus americanus*)
11. Blossom, green (pearlymussel) (*Epioblasma torulosa gubernaculum*)
12. Blossom, tubercled (pearlymussel) (*Epioblasma torulosa torulosa*)
13. Blossom, turgid (pearlymussel) (*Epioblasma turgidula*)
14. Blossom, yellow (pearlymussel) (*Epioblasma florentina florentina*)
15. Butterfly, Karner blue (*Lycaeides melissa samuelis*)
16. Butterfly, Mitchell's satyr (*Neonympha mitchellii mitchellii*)
17. Catspaw, white (pearlymussel) (*Epioblasma obliquata perobliqua*)
18. Cavefish, Ozark (*Amblyopsis rosae*)
19. Cavesnail, Tumbling Creek (*Antrobia culveri*)
20. Chicken, Lesser-Prairie (*Tympanuchus pallidicinctus*)
21. Chub, slender (*Erimystax cahni*)
22. Chub, spotfin (*Erimonax monachus*)
23. Clubshell (*Pleurobema clava*)
24. Clubshell, black (*Pleurobema curtum*)
25. Clubshell, ovate (*Pleurobema perovatum*)
26. Clubshell, southern (*Pleurobema decisum*)
27. Combshell, Cumberlandian (*Epioblasma brevidens*)
28. Combshell, southern (*Epioblasma penita*)
29. Combshell, upland (*Epioblasma metastriata*)
30. Crane, Mississippi Sandhill (*Grus canadensis pulla*)
31. Crane, Whooping (*Grus americana*)
32. Crayfish, cave (*Cambarus aculabrum*)
33. Crayfish, cave (*Cambarus zophonastes*)
34. Crayfish, Nashville (*Orconectes shoupi*)
35. Dace, blackside (*Phoxinus cumberlandensis*)
36. Dace, Laurel (*Chrosomus saylora*)
37. Darter, amber (*Percina antesella*)
38. Darter, bayou (*Etheostoma rubrum*)
39. Darter, bluemask (=jewel) (*Etheostoma sp.*)
40. Darter, boulder (*Etheostoma wapiti*)
41. Darter, Cumberland (*Etheostoma susanae*)
42. Darter, duskytail (*Etheostoma percnurum*)

43. Darter, leopard (*Percina pantherina*)
44. Darter, Niangua (*Etheostoma nianguae*)
45. Darter, slackwater (*Etheostoma boschungii*)
46. Darter, snail Entire (*Percina tanasi*)
47. Darter, yellowcheek (*Etheostoma moorei*)
48. Dragonfly, Hine's emerald (*Somatochlora hineana*)
49. Elktoe, Appalachian (*Alasmidonta raveneliana*)
50. Elktoe, Cumberland (*Alasmidonta atropurpurea*)
51. Fanshell (*Cyprogenia stegaria*)
52. Fatmucket, Arkansas (*Lampsilis powellii*)
53. Ferret, black-footed (*Mustela nigripes*)
54. Frog, dusky gopher (*Rana sevosia*)
55. Heelsplitter, Alabama (=inflated) (*Potamilus inflatus*)
56. Hellbender, Ozark (*Cryptobranchus alleganiensis bishopi*)
57. Higgins eye (pearlymussel) (*Lampsilis higginsii*)
58. Kidneyshell, fluted (*Ptychobranhus subtentum*)
59. Kidneyshell, triangular (*Ptychobranhus greenii*)
60. Lampmussel, Alabama (*Lampsilis virescens*)
61. Lilliput, pale (pearlymussel) (*Toxolasma cylindrellus*)
62. Logperch, Conasauga (*Percina jenkinsi*)
63. Lynx, Canada (*Lynx canadensis*)
64. Madtom, chunky (*Noturus crypticus*)
65. Madtom, Neosho Entire (*Noturus placidus*)
66. Madtom, pygmy (*Noturus stanauli*)
67. Madtom, Scioto (*Noturus trautmani*)
68. Madtom, smoky (*Noturus baileyi*)
69. Madtom, yellowfin (*Noturus flavipinnis*)
70. Manatee, West Indian (*Trichechus manatus*)
71. Mapleleaf, winged (*Quadrula fragosa*)
72. Marstonia, royal (snail) (*Pyrgulopsis ogmorhapha*)
73. Moccasinshell, Alabama (*Medionidus acutissimus*)
74. Moccasinshell, Coosa (*Medionidus parvulus*)
75. Monkeyface, Appalachian (pearlymussel) (*Quadrula sparsa*)
76. Monkeyface, Cumberland (pearlymussel) (*Quadrula intermedia*)
77. Mucket, Neosho (*Lampsilis rafinesqueana*)
78. Mucket, orangenacre (*Lampsilis perovalis*)
79. Mucket, pink (pearlymussel) Entire (*Lampsilis abrupta*)
80. Mussel, oyster (*Epioblasma capsaeformis*)
81. Mussel, scaleshell (*Leptodea leptodon*)
82. Mussel, sheepnose (*Plethobasus cyphus*)
83. Mussel, snuffbox (*Epioblasma triquetra*)
84. Pearlshell, Louisiana (*Margaritifera hembeli*)
85. Pearlymussel, birdwing (*Lemiox rimosus*)
86. Pearlymussel, cracking (*Hemistena lata*)
87. Pearlymussel, Curtis (*Epioblasma florentina curtisii*)
88. Pearlymussel, dromedary (*Dromus dromas*)
89. Pearlymussel, littlewing (*Pegias fabula*)
90. Pearlymussel, Slabside (*Pleuonaia dolabelloides*)
91. Pigtoe, Cumberland (*Pleurobema gibberum*)
92. Pigtoe, finereyed (*Fusconaia cuneolus*)
93. Pigtoe, flat (*Pleurobema marshalli*)

94. Pigtoe, Georgia (*Pleurobema hanleyianum*)
95. Pigtoe, rough (*Pleurobema plenum*)
96. Pigtoe, shiny (*Fusconaia cor*)
97. Pigtoe, southern (*Pleurobema georgianum*)
98. Pimpleback, orangefoot (pearlymussel) (*Plethobasus cooperianus*)
99. Plover, piping except Great Lakes watershed (*Charadrius melodus*)
100. Plover, piping Great Lakes watershed (*Charadrius melodus*)
101. Pocketbook, fat (*Potamilus capax*)
102. Pocketbook, Ouachita rock (*Arkansia wheeleri*)
103. Pocketbook, speckled (*Lampsilis streckeri*)
104. Purple Cat's paw (=Purple Cat's paw pearlymussel) (*Epioblasma obliquata obliquata*)
105. Rabbitsfoot (*Quadrula cylindrica cylindrica*)
106. Rabbitsfoot, rough (*Quadrula cylindrica strigillata*)
107. Riffleshell, northern (*Epioblasma torulosa rangiana*)
108. Riffleshell, tan (*Epioblasma florentina walkeri* (=E. walkeri))
109. Ring pink (mussel) (*Obovaria retusa*)
110. Riversnail, Anthony's (*Athearnia anthonyi*)
111. Sawfish, smalltooth TX, FL (*Pristis pectinata*)
112. Sculpin, grotto (*Cottus sp.*)
113. Sea turtle, green (*Chelonia mydas*)
114. Sea turtle, hawksbill (*Eretmochelys imbricata*)
115. Sea turtle, Kemp's ridley (*Lepidochelys kempii*)
116. Sea turtle, leatherback (*Dermochelys coriacea*)
117. Sea turtle, loggerhead Northwest Atlantic DPS (*Caretta caretta*)
118. Shiner, Arkansas River (*Notropis girardi*)
119. Shiner, blue (*Cyprinella caerulea*)
120. Shiner, Topeka (*Notropis topeka* (=tristis))
121. Snail, Iowa Pleistocene (*Discus macclintocki*)
122. Snail, painted snake coiled forest (*Anguispira picta*)
123. Snake, copperbelly water (*Nerodia erythrogaster neglecta*)
124. Spectaclecase (mussel) (*Cumberlandia monodonta*)
125. Spider, spruce-fir moss (*Microhexura montivaga*)
126. Squirrel, Carolina northern flying (*Glaucomys sabrinus coloratus*)
127. Stirrupshell (*Quadrula stapes*)
128. Sturgeon, gulf (*Acipenser oxyrinchus desotoi*)
129. Sturgeon, pallid (*Scaphirhynchus albus*)
130. Tern, least interior pop. (*Sterna antillarum*)
131. Tiger beetle, Salt Creek (*Cicindela nevadica lincolniana*)
132. Tortoise, gopher (*Gopherus polyphemus*)
133. Turtle, ringed map (*Graptemys oculifera*)
134. Turtle, yellow-blotched map (*Graptemys flavimaculata*)
135. Vireo, black-capped (*Vireo atricapilla*)
136. Warbler, Kirtland's (*Setophaga kirtlandii*)
137. Wartyback, white (pearlymussel) (*Plethobasus cicatricosus*)
138. Whale, finback (*Balaenoptera physalus*)
139. Whale, humpback (*Megaptera novaeangliae*)
140. Wolf, gray (*Canis lupus*)
141. Woodpecker, red-cockaded (*Picoides borealis*)

Plants

142. Aster, decurrent false (*Boltonia decurrens*)

143. Aster, Ruth's golden (*Pityopsis ruthii*)
144. Avens, spreading (*Geum radiatum*)
145. bladderpod, Missouri (*Physaria filiformis*)
146. Bladderpod, Spring Creek (*Lesquerella perforata*)
147. Bluet, Roan Mountain (*Hedysotis purpurea* var. *montana*)
148. Bush-clover, prairie (*Lespedeza leptostachya*)
149. Butterfly plant, Colorado (*Gaura neomexicana* var. *coloradensis*)
150. Chaffseed, American (*Schwalbea americana*)
151. Clover, running buffalo (*Trifolium stoloniferum*)
152. Daisy, Lakeside (*Hymenoxys herbacea*)
153. Fern, American hart's-tongue (*Asplenium scolopendrium* var. *americanum*)
154. *Geocarpon minimum* (No common name)
155. Goldenrod, Blue Ridge (*Solidago spithamea*)
156. Goldenrod, Short's (*Solidago shortii*)
157. Grass, Tennessee yellow-eyed (*Xyris tennesseensis*)
158. Ground-plum, Guthrie's (=Pyne's) (*Astragalus bibullatus*)
159. Harperella (*Ptilimnium nodosum*)
160. Iris, dwarf lake (*Iris lacustris*)
161. Ladies'-tresses, Ute (*Spiranthes diluvialis*)
162. Lichen, rock gnome (*Gymnoderma lineare*)
163. Lily, Minnesota dwarf trout (*Erythronium propullans*)
164. Locoweed, Fassett's (*Oxytropis campestris* var. *chartacea*)
165. Milkweed, Mead's (*Asclepias meadii*)
166. Monkshood, northern wild (*Aconitum noveboracense*)
167. Orchid, eastern prairie fringed (*Platanthera leucophaea*)
168. Orchid, western prairie fringed (*Platanthera praeclara*)
169. Penstemon, blowout (*Penstemon haydenii*)
170. Pitcher-plant, green (*Sarracenia oreophila*)
171. Pogonia, small whorled (*Isotria medeoloides*)
172. Pondberry (*Lindera melissifolia*)
173. Potato-bean, Price's (*Apios priceana*)
174. Prairie-clover, leafy (*Dalea foliosa*)
175. Quillwort, Louisiana (*Isoetes louisianensis*)
176. Rock-cress, Braun's (*Arabis perstellata*)
177. Rosemary, Cumberland (*Conradina verticillata*)
178. Roseroot, Leedy's (*Rhodiola integrifolia* ssp. *leedyi*)
179. Sandwort, Cumberland (*Arenaria cumberlandensis*)
180. Skullcap, large-flowered (*Scutellaria montana*)
181. Sneezeweed, Virginia (*Helenium virginicum*)
182. Spiraea, Virginia (*Spiraea virginiana*)
183. Thistle, Pitcher's (*Cirsium pitcheri*)

Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Field – Accounting for Spray Drift and Runoff Mitigation Labeling Restrictions

The spray drift (in-field buffer) and rainfast mitigations discussed in the cotton section 3 ecological risk assessment (D404823), the concurrently issued soybean addendum (D426789) and the beginning of this assessment are anticipated to restrict dicamba and DCSA residues above any threshold toxicity values to the agricultural field. Therefore, the following table describes the habitat and rationale for all listed species that were determined to not use cotton and soybean fields or resources that may overlap with the dicamba DGA uses.

Species	Habitat	Rationale	Source
Animals			
<u>Acornshell, southern (Epioblasma othcaloogensis)</u>	The southern acornshell is historically restricted to shoals in small rivers to small streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS 2000, p. 57).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2000. Recovery Plan for Mobile River Basin Aquatic Ecosystem. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Amphipod, Illinois cave (Gammarus acherondytes)</u>	The Illinois cave amphipod lives in streams primarily in the dark zone of caves in parts of the Salem Plateau of Illinois. Little is known of the biology and habitat requirements of this species although it has been collected in mainstream gravel riffles, smaller tributary streams, rimstone pools, and from streams with silt overlying bedrock. As a group, amphipods require cool water temperatures and are intolerant of wide ranges in temperature (US FWS 2002)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920.pdf

Species	Habitat	Rationale	Source
<u>Bat, gray</u> <u>(Myotis</u> <u>grisescens)</u>	Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when migrating (US FWS, 1982. pp. 6-7).	The proposed dicamba DGA uses are not expected to encompass caves or the forest/open water areas where bats forage.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf

Species	Habitat	Rationale	Source
<u>Bean, Cumberland (pearly mussel) (Villosa trabalis)</u>	Restricted typically to tributary streams of the upper reaches of the Tennessee and Cumberland Rivers. This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, <i>V. trabalis</i> is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species (US FWS 2010, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc3244.pdf
<u>Bean, purple (Villosa perpurpurea)</u>	Inhabits small headwater streams (Neves 1991) to medium-sized rivers (Gordon 1991). It is found in moderate to fast-flowing riffles with sand, gravel, and cobble substrates (Neves 1991) and rarely occurs in deep pools or slack water (Ahlstedt 1991a). It is sometimes found out of the main current adjacent to water-willow beds and under flat rocks (Ahlstedt	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
	1991a, Gordon 1991) (US FWS 2004, p. 19).		
<u>Bean, rayed</u> (<u>Villosa fabalis</u>)	The rayed bean is generally known from smaller, headwater creeks, but occurrence records exist from larger rivers (Cummings and Mayer 1992, p. 142; Parmalee and Bogan 1998, p. 244). They are usually found in or near shoal or riffle (short, shallow length of stream where the stream flows more rapidly) areas, and in the shallow, wave-washed areas of glacial lakes, including Lake Erie (West et al. 2000, p. 253). In Lake Erie, the species is generally associated with islands in the western portion of the lake. Preferred substrates typically include gravel and sand. The rayed bean is oftentimes found among vegetation (water willow (<i>Justicia americana</i>) and water milfoil (<i>Myriophyllum</i> sp.)) in and adjacent to riffles and shoals (Watters 1988b, p. 15; West et al. 2000, p. 253) (US FWS 2012, p. 8633).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS 2012 - Federal Register Determination of Endangered Status. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
<u>Blossom, green</u> (<u>pearlymussel</u>) (<u>Epioblasma</u> <u>torulosa</u> <u>gubernaculum</u>)	Cumberlandian freshwater mussels are most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. The	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060228.pdf USFWS. 2007. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc1961.pdf

Species	Habitat	Rationale	Source
	<p>mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS 1984, p. 5)</p> <p>The last known record for the green-blossom pearly mussel was a live individual collected in 1982 (US FWS 2007, p. 7).</p>		
<u>Blossom, tubercled</u> (pearlymussel) (<u>Epioblasma torulosa torulosa</u>)	Occurs only in headwater tributaries of the Tennessee River (US FWS 1985, p. 11).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850125.pdf
<u>Blossom, turgid</u> (pearlymussel) (<u>Epioblasma turgidula</u>)	The last known collection of the turgid-blossom pearly mussel was a fresh-dead specimen found in the Duck River, Tennessee, in 1965 (US FWS 2007, p. 7)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2007. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc1961.pdf
<u>Blossom, yellow</u> (pearlymussel) (<u>Epioblasma florentina florentina</u>)	The last known specimen of the yellow-blossom pearly mussel was recorded in the Little Tennessee River and Citico Creek, Tennessee in 1967 (US FWS 2007, p. 7)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2007. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc1961.pdf
<u>Butterfly, Karner blue</u> (<u>Lyciaides melissa samuelis</u>)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy (US FWS, 2003. pp.28-30)	The proposed dicamba DGA uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf

Species	Habitat	Rationale	Source
<u>Butterfly,</u> <u>Mitchell's satyr</u> <u>(Neonympha</u> <u>mitchellii</u> <u>mitchellii)</u>	Mitchell's satyr habitat is best characterized as a sedge-dominated fen community; Known habitats are all peatlands but range along a continuum from prairie/bog fen to sedge meadow/swamp. However, certain attributes at each site remain fairly constant. All historical and active habitats have a herbaceous community which is dominated by sedges, usually <i>Carex stricta</i> , with scattered deciduous and/or coniferous trees, most often <i>L. laricina</i> or <i>Juniperus virginiana</i> (red cedar) (US FWS 1998, pp. 11-12).	The proposed dicamba DGA uses are not expected to overlap with wetlands or areas with sedge communities.	USFWS 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf
<u>Catspaw, white</u> <u>(pearlymussel)</u> <u>(Epioblasma</u> <u>obliquata</u> <u>perobliquata)</u>	The white cat's paw pearly mussel is currently known to exist in only a 3-mile portion of Fish Creek in Williams County in northwest Ohio. Museum records indicate that it historically occurred in Indiana in the Wabash, White, Tippecanoe, Maumee, and St. Joseph rivers, and Ohio in the Maumee and St. Joseph Rivers and Fish Creek. It was last observed in 1999 (US FWS, 2009, p. 7). The Recovery Plan indicates that the habitat is unclear but appears to be riffle run reaches of small to moderately large rivers (US FWS, 1990, p. 16).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900125.pdf

Species	Habitat	Rationale	Source
<u>Cavefish, Ozark</u> (<u>Amblyopsis</u> <u>rosae</u>)	Cavefish occur in groundwater habitats (the Springfield Plateau Aquifer) within Boone and Burlington Formation limestones, especially in cave streams with chert rubble substrate, and occasionally in wells and sinkholes, and even in the soil phreatic zone (Poulson, 1961, 1963; USFWS, 1986). Woods and Inger (1957) suggest cavefish dispersal occurs through phreatic cave passages. Noltie and Wicks (2001) suggests that due to shale geologic confining units, Ozark cavefish are distributed in near surface and epikarst habitats (US FWS 2011).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3850.pdf
<u>Cavesnail,</u> <u>Tumbling Creek</u> (<u>Antrobia</u> <u>culveri</u>)	Troglobitic creek - Tumbling Creek ranges from 0.014 to 2.8 cubic meters per second (~ 0.5 to 100 cubic ft. per second); the mean annual flow is between 0.08 to 0.14 cubic meters per second (~ 3 to 5 cubic feet per second). The stream contains many chert pebbles which have been highly polished by natural abrasion within the cave...The land surface above the cave includes a variety of woodland and glade natural communities as well as pastures and/or	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030922a.pdf

Species	Habitat	Rationale	Source
	open fields. (US FWS 2003, p. 10).		
<u>Chub, slender</u> (<u>Erimystax</u> <u>cahni</u>)	The slender chub is restricted to the upper Tennessee River drainage in Tennessee and Virginia (US FWS 2014, p. 6)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc4357.pdf
<u>Chub, spotfin</u> (<u>Erimonax</u> <u>monachus</u>)	The species is an insectivore, feeding diurnally presumably by both sight and taste in benthic areas of slow to swift current over various substrates with little siltation. Streams may range from 15-60 m in width and, where occupied, 0.3-10.0 m in depth. Water temperature in their summer habitat usually reaches greater than 20°C, and submerged macrophytes are usually absent, occasionally common. The species has been observed associated with sand, gravel, rubble, boulder, and bedrock substrates (Jenkins and Burkhead, 1982) (US FWS 1983, p. 15).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/831121.pdf
<u>Clubshell</u> (<u>Pleurobema</u> <u>clava</u>)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf
<u>Clubshell, black</u> (<u>Pleurobema</u> <u>curtum</u>)	This species inhabits the Tombigbee River, which is a major western tributary of the Mobile Basin. It is characterized by an	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf

Species	Habitat	Rationale	Source
	increasing number of sand and gravel shoals and decreasing channel size (US FWS, 1989, p. 1)		
<u>Clubshell, ovate (Pleurobema perovatum)</u>	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 56)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Clubshell, southern (Pleurobema decisum)</u>	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 58)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Combshell, Cumberlandian (Epioblasma brevidens)</u>	This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse, sand, gravel, cobble, and boulders. It is not associated with small stream habitats and tends not to extend as far upstream in tributaries (US FWS 2004, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
<u>Combshell, southern (Epioblasma penita)</u>	This species inhabits the Tombigbee River, which is a major western tributary of the Mobile Basin. It is characterized by an increasing number of sand and gravel shoals and decreasing channel size (US FWS, 1989, p. 1)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Combshell, upland (Epioblasma metastrata)</u>	Restricted to shoals in rivers and large streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS, 2000, p. 61)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4153.pdf

Species	Habitat	Rationale	Source
<u>Crayfish, cave</u> <u>(Cambarus</u> <u>aculabrum)</u>	This species inhabits troglobitic Stream - Along the walls of pools or along stream edges. They can be found on silt, gravel, rubble and bedrock, or even hiding underneath trash, such as an old discarded boot.; Logan Cave, Bear Hollow Cave, Elm Springs, and Old Pendergrass (US FWS 2013, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2013. Five Year Recovery. http://ecos.fws.gov/docs/five_year_review/doc4153.pdf
Crayfish, Cave (<i>Cambarus zophonastes</i>)	This species inhabits troglobitic stream - muddy stream bottoms, cave stream walls, and other in-stream habitats; found in Hell Creek, Nesbitt Spring: groundwater upwelling in Town Branch... approximately 40 miles northwest of the other known sites, which are found near one another, suggesting a much wider subterranean distribution of the species. (6)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. Hell Creek Cave Crayfish 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4153.pdf
<u>Crayfish,</u> <u>Nashville</u> <u>(Orconectes</u> <u>shoupi)</u>	Much of the stream bank where this species occurs is vegetated with trees and shrubs (Bouchard 1976). The Nashville crayfish has been found in a wide range of environments including gravel and cobble runs, pools with up to 10 centimeters (cm) of settled sediment, and under slabrocks and other cover (the largest crayfish are usually under cover) (USFWS 1989). The species is	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890208.pdf

Species	Habitat	Rationale	Source
	highly photosensitive and is usually found under cover during the day (Bouchard 1976). Canopy cover appears important, as O'Bara et al. (1985) reported that all sites they sampled had canopy cover of 60 to 90 percent. The species has been found in small pools where the flow was intermittent (Stark 1986, Miller and Hartfield 1985). Gravel-cobble substrate provides good cover for juveniles (Stark 1986, Miller and Hartfield 1985). Females seek out large slabrocks when they are carrying eggs and young. These secluded places are also needed for molting (USFWS 1989).		
<u>Dace, blackside (Phoxinus cumberlandensis)</u>	This species inhabits cool, small, upland streams with moderate flows. The fish is generally associated with undercut stream banks and large rocks, and it is usually found within well-vegetated watersheds with good riparian vegetation (US FWS 1988, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/880817.pdf
<u>Dace, Laurel (Chrosomus saylori)</u>	This species has most often been collected from pools or slow runs from undercut banks or beneath slab-rock boulders, typically in first or second order, clear, cool, streams. Substrates typically consist of a mixture of	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designated Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf

Species	Habitat	Rationale	Source
	cobble, rubble, and boulders, and the streams tend to have a dense riparian zone consisting largely of mountain laural (US FWS, 2012, p. 63606)		
<u>Darter, amber</u> (<u>Percina</u> <u>antesella</u>)	This species inhabits gentle riffle areas over sand, gravel, and cobble substrates. Aquatic vegetation that develops in riffles provides habitat for feeding and cover (US FWS, 1986, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf
<u>Darter, bayou</u> (<u>Etheostoma</u> <u>rubrum</u>)	The portion of Bayou Pierre System serving as habitat for this species is a meandering stream with stable gravel riffles or sandstone exposures (US FWS, 1990, p. 3).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900710.pdf
<u>Darter, bluemask</u> (= <u>jewel</u>) (<u>Etheostoma</u> <u>sp.</u>)	This species inhabits slow to moderate current over clean sand and fine gravel at depths of 4 to 20 inches; it typically occurs just downstream of riffles or along the margins of pools and runs (US FWS, 1997, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970725.pdf
<u>Darter, boulder</u> (<u>Etheostoma</u> <u>wapiti</u>)	This species inhabits warm-water riverine environments and has been found only in moderate to fast current over boulder/slab rock substrate in water over 2 feet deep (US FWS, 1989, p. 2).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890727.pdf
<u>Darter, Cumberland</u> (<u>Etheostoma</u> <u>susanae</u>)	This species inhabits pools or shallow runs of low to moderate gradient sections of streams with stable	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designated Critical Habitat.

Species	Habitat	Rationale	Source
	sand, silt, or sand-covered bedrock substrates (US FWS, 2012, p. 63605).		http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>Darter, duskytail (Etheostoma percunrum)</u>	This species inhabits rocky areas in gently flowing shallow pools and runs in large creeks and moderately large rivers in the Tennessee and Cumberland River Systems (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/duskytaildarter_RP.pdf
<u>Darter, leopard (Percina pantherina)</u>	The leopard darter typically inhabits pools having predominantly rubble and boulder substrates with current velocities less than 48 centimeters/second (Jones 1984, Lechner et al. 1987). Preferred water depths are generally 20-102 cm (Jones et al. 1984; James 1989), although joint Service/U.S. Forest Service surveys over the past 10 years have observed leopard darters from depths over 4.0 meters; large to intermediate streams having relatively steep grade (US FWS 2012, p. 12).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4107.2.12%20with%20signatures.pdf
<u>Darter, Niangua (Etheostoma nianguae)</u>	Medium sized streams of the Salem Plateau, of order 3, 4, and 5, having gradients of 3 to 21 feet/mile, elevation of stream bed =550-1050 ft, moderately clear upland creeks draining hilly topography underlain by bedrocks consisting principally of chert-	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890717.pdf

Species	Habitat	Rationale	Source
	bearing dolomites (US FWS 1989, pp. 9-10).		
<u>Darter, slackwater (Etheostoma boschungii)</u>	Nonbreeding habitat is small to moderately large streams. The current is usually slow, and under normal conditions, the flow ranges from still to 0.34 m/sec. In small streams, the darters show no position preference; however, in large streams they seem to confine themselves to near the banks or to undercuts in the banks. They also occur on gravel infiltrated with silt, on silt and mud, or in a combination of these. The breeding habitat is seepage water in open fields and woods (US FWS, 1984, pp. 7-8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840308.pdf
<u>Darter, snail (Percina tanasi)</u>	This species occupies seven of nine tributaries of the upper Tennessee River in Alabama, Georgia and Tennessee (US FWS, 2013, p. 10).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4136.pdf
<u>Darter, yellowcheek (Etheostoma moorei)</u>	Devil's, Middle, South, and Archey forks of the Little Red River in Cleburne, Searcy, Stone, and Van Buren Counties... primarily within the Boston Mountains subdivision of the Ozark Plateau. Inhabits high-gradient headwater	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf

Species	Habitat	Rationale	Source
	tributaries with clear water; permanent flow; moderate to strong riffles; and gravel, cobble, and boulder substrates (Robison and Buchanan 1988, p. 429) (US FWS 2012, p. 63605).		
<u>Dragonfly,</u> <u>Hine's emerald</u> <u>(Somatochlora</u> <u>hineana)</u>	<p>The hine's emerald dragonfly occupies grass marshes and sedge meadows fed primarily by water from a mineral source or fens. Two important characteristics of the habitat appear to be groundwater-fed, shallow water slowly flowing through vegetation, and underlying dolomitic or limestone bedrock. Parts of the aquatic channels are typically covered by vegetation such as cattails or sedges. Soils can range from organic muck to mineral soils like marl. Two other important components are areas of open vegetation for foraging and forests, trees or shrubs that provide shaded areas for perching or roosting. Nearby adjacent forests may be deciduous (Illinois) or conifer (Wisconsin and Michigan).</p> <p>Larvae are usually found in small flowing streamlets within cattail marshes, sedge meadows, and</p>	The proposed dicamba DGA uses are not expected to overlap with grass marshes, sedge meadows, forested areas, or other habitat where the Hine's emerald dragonfly is expected to be found.	USFWS. 2001. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/010927.pdf

Species	Habitat	Rationale	Source
	<p>hummocks. Places with silt, leaf litter, and decaying grasses as a substrate are often used (US FWS, 2001, p. 15-16.).</p> <p>Critical Habitat of 26,531 acres have been designated in Michigan, Illinois, Wisconsin, and Missouri. Almost half of this is Mackinac County, MI.</p>		
<u>Elktoe, Appalachian (Alasmidonta raveneliana)</u>	<p>This species has been reported from relatively shallow medium-sized creeks and rivers with cool, well-oxygenated, and moderate- to fast-flowing water. It has been observed in gravelly substrata, often mixed with cobble and boulders; in cracks in bedrock; and occasionally in relatively silt-free, coarse, sandy substrata (US FWS, 1996, Executive Summary).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960826.pdf</p>
<u>Elktoe, Cumberland (Alasmidonta atropurpurea)</u>	<p>This species inhabits medium-sized rivers and may extend into headwater streams where it is often the only mussel present (Gordon and Layzer 1989, Gordon 1991). Gordon and Layzer (1989) reported that the species appears to be most abundant in flats, which were described as shallow pool areas lacking the bottom contour development of typical pools, with sand and scattered</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf</p>

Species	Habitat	Rationale	Source
	cobble/boulder material, relatively shallow depths, and slow (almost imperceptible) currents. They also report the species from swifter currents and in areas with mud, sand, and gravel substrates (US FWS, 2004, p. 18).		
<u>Fanshell (Cyprogenia stegaria)</u>	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf
<u>fatmucket, Arkansas (Lampsilis powellii)</u>	Four microhabitat types that include: 1) long pools with cobble and rock as primary substrate types, 2) backwater areas downstream of peninsulas or islands covered with water willow (<i>Justicia americana</i>) and with cobble and sand as the dominant substrate, 3) slow moving pools upstream from water willow islands with sand, gravel, and cobble substrate, and 4) overflow, secondary channel pools, and tributary confluence areas with sand, cobble, and some rock substrate (US FWS 2013, p. 5)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
<u>Ferret, black-footed (Mustela nigripes)</u>	The black-footed ferret relies on prairie dog colonies for both food and shelter.	The proposed dicamba DGA uses are not expected to overlap with prairie dog colonies.	USFWS. 2008. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2364.pdf
<u>Frog, dusky gopher (Rana sevosa)</u>	Upland sandy habitats (forest dominated by longleaf pine (Pinus	The proposed dicamba DGA uses are not expected to overlap with	USFWS. 2011. Federal Register Notice: Designation of Critical Habitat.

Species	Habitat	Rationale	Source
	palustris)), wetlands (ephemeral ponds) embedded within the forest ...Adults and subadults spend the majority of their lives underground (in gopher tortoise (<i>Gopherus polyphemus</i>) and mammal burrows and holes under old stumps)...During the breeding season, Mississippi gopher frogs leave their subterranean retreats in the uplands and migrate to their breeding sites during rains associated with passing cold fronts. Breeding sites are ephemeral (seasonally flooded) isolated ponds (not connected to other water bodies) located in the uplands. Both forested uplands and isolated wetlands (see further discussion of isolated wetlands in “Sites for Breeding, Reproduction, and Rearing of Offspring” section) are needed to provide space for individual and population growth and normal behavior. (US FWS 2011, p. 59777-59778)	forested areas, wetlands, or ephemeral isolated ponds.	http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf

Species	Habitat	Rationale	Source
<u>Heelsplitter,</u> <u>Alabama</u> <u>(=inflated)</u> <u>(Potamilus</u> <u>inflatus)</u>	This species prefers a soft, stable substrate in slow to moderate currents. It has been found in sand, mud, silt and sandy-gravel, but not in large or armored gravel (US FWS, 1993, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930413.pdf
<u>Hellbender,</u> <u>Ozark</u> <u>(Cryptobranchus</u> <u>alleganiensis</u> <u>bishopi)</u>	Cool, clear streams and rivers with many large rocks...small hellbenders hide beneath large rocks and also small stones in gravel beds. Adults spend most of their life under large, flat rocks; typically limestone or dolomite [rocks], and in moderate to deep (less than 3 to 9.8 feet (less than 1 to 3 meters)), rocky, fast-flowing streams in the Ozark Plateau (Johnson 2000, p. 42; Fobes and Wilkinson 1995, pp. 5–7). In spring-fed streams, Ozark Hellbenders will often concentrate downstream of the spring, where there is little water temperature change throughout the year (US FWS 2011, p. 61956).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2011. Federal Register Notice: Listing Document. http://www.gpo.gov/fdsys/pkg/FR-2011-10-06/pdf/2011-25690.pdf
<u>Higgins eye</u> <u>(pearlymussel)</u> <u>(Lampsilis</u> <u>higginsii)</u>	The higgins eye pearlymussel is characterized as an inhabitant of large rivers with loose substrates and low velocities. Many of the largest populations are in the Mississippi River, and all are in its upper drainage (US FWS, 2004, p. 7-8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040714.pdf

Species	Habitat	Rationale	Source
<u>Kidneyshell, fluted</u> (<u>Ptychobranchius subtentum</u>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
<u>Kidneyshell, triangular</u> (<u>Ptychobranchius greenii</u>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 60)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf
<u>Lampmussel, Alabama</u> (<u>Lampsilis virescens</u>)	This species inhabits sand and gravel substrates in small to medium sized streams (US FWS, 1985, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf
<u>Lilliput, pale</u> (<u>pearlymussel</u>) (<u>Toxolasma cylindrellus</u>)	This species is observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840822.pdf
<u>Logperch, Conasauga</u> (<u>Percina jenkinsi</u>)	This species has been collected in deep shuts and flowing pools with clear, clean gravel and mixed rubble substrates in areas with moderate to swift currents (US FWS, 1986, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf

Species	Habitat	Rationale	Source
Lynx, Canada (<i>Lynx canadensis</i>)	PCE: Boreal forest landscapes with large populations of snowshoe hares. Distribution and abundance of prey and microclimate influence movement, hunting behavior, and den and resting site locations. Areas with dense cover.	The proposed dicamba DGA uses are not expected to overlap with boreal forests. The lynx's prey, snowshoe hares, also do not overlap with the proposed dicamba DGA use sites.	USFWS. 2014. Federal Register Notice: Designation of Critical Habitat http://www.gpo.gov/fdsys/pkg/FR-2014-09-12/pdf/2014-21013.pdf
<u>Madtom</u> , <u>chucky</u> Entire (<i>Noturus crypticus</i>)	This species has been found in stream runs with slow to moderate current over pea gravel, cobble, or slab-rock boulder substrates (US FWS, 2012, p. 63606)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>Madtom</u> , <u>Neosho</u> (<i>Noturus placidus</i>)	Benthic species inhabits shallow gravel substrates. The species remains primarily inactive and hidden in bottom substrate during the day, and comes out at night to forage for aquatic invertebrates (Moss 1981). The majority of Neosho madtom collections are from areas with gravel substrates, primarily gravel in the size range of 0.5 to 2.5 inches (12 – 64 mm) in diameter. Most collections are made in the Spring and Neosho Rivers in shallow water, generally less than three feet deep (<1 m). Within these systems, no significant differences in madtom preferences for depth, velocity, and substrate size were found but gravel riffles with currents of one to four	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4140.pdf

Species	Habitat	Rationale	Source
	feet per second (<1.25 m/sec.) are preferred by adults (Moss 1981; Fuselier and Edds 1994; Wildhaber et al. 2000a) (US FWS 2013, pp. 6).		
<u>Madtom, pygmy (Noturus stanauli)</u>	This species inhabits shallow shoals, where the current is moderate to strong and where there is pea-sized gravel or fine sand substrates, in moderately large rivers of the Tennessee River system (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940927a.pdf
<u>Madtom, Scioto (Noturus trautmani)</u>	Only 18 individuals have ever been collected, all found along one stretch of Big Darby Creek in Ohio (US FWS, 2009, p. 4). The scioto madtom prefers stream riffles of moderate current over gravel bottoms with high quality water that is free of suspended sediments. The riffle habitat where the 18 individual were collected was comprised of glacial cobble, gravel, sand, and silt substrate with some large boulders (US FWS, 2009, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3057.pdf
<u>Madtom, smoky (Noturus baileyi)</u>	This species is restricted to Citico Creek, primarily within the Cherokee National Forest, Monroe County, Tennessee (US FWS, 1985,p. 1)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060313b.pdf

Species	Habitat	Rationale	Source
<u>Madtom</u> , <u>yellowfin</u> (<u>Noturus</u> <u>flavipinnis</u>)	This species prefers pool habitats beneath cobble and small boulder substrates (Miller 2011). The strongest habitat models identified preferred pools for yellowfin madtoms as greater than 40 meters in length with gravel being the main substrate beneath cover rocks (Miller 2011). (US FWS, 2012, p. 16).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4146.pdf
<u>Manatee</u> , <u>West Indian</u> (<u>Trichechus</u> <u>manatus</u>)	This species lives in freshwater, brackish and marine habitats (US FWS, 2001, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2001. Recovery Plan- Third Revision. http://ecos.fws.gov/docs/recovery_plan/011030.pdf
<u>Mapleleaf</u> , <u>winged</u> (<u>Quadrula</u> <u>fragosa</u>)	The general habitat is poorly known, although it has been characterized as a large stream species. It has been collected on mud, mud-covered gravel, and gravel substrates. In its current location in the St. Croix River, it occurs in riffles with clean gravel, sand, or rubbles substrates and fast current. It was not found in a natural impoundment of the river (US FWS, 1997, p. 5-6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970625.pdf
<u>Marstonia</u> , <u>royal</u> (<u>snail</u>) (<u>Pyrgulopsis</u> <u>ogmorhaphes</u>)	This species is found in Blue Spring, which is in the water supply for the town of Jasper, Tennessee, and downstream to the State Highway 64 bridge (US FWS, 1995, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950811.pdf

Species	Habitat	Rationale	Source
<u>Moccasinshell, Alabama (Medionidus acutissimus)</u>	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 51)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Moccasinshell, Coosa (Medionidus parvulus)</u>	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 52)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Monkeyface, Appalachian (pearlymussel) (Quadrula sparsa)</u>	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709.pdf
<u>Monkeyface, Cumberland (pearlymussel) (Quadrula intermedia)</u>	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709b.pdf
<u>Mucket, Neosho (Lampsilis rafinesqueana)</u>	The Neosho mucket is associated with shallow riffles and runs comprising gravel substrate and moderate to swift currents. The species is most often found in areas with swift current, but in	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Proposed Listing Document. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf

Species	Habitat	Rationale	Source
	Shoal Creek and the Illinois River it prefers near-shore areas or areas out of the main current (Oesch 1984, p. 221; Obermeyer 2000, pp. 15–16) (US FWS 2012, p. 63443).		
<u>Mucket, orangenacre (Lampsilis perovalis)</u>	Currently restricted to high quality stream and small river habitat, the species is found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS 2000, p. 55)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Mucket, pink (pearlymussel) (Lampsilis abrupta)</u>	<p>The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10).</p> <p>The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the water is flowing (US FWS, 1985, p. 10).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf
<u>Mussel, oyster (Epioblasma capsaeformis)</u>	This species is generally adapted to live in the gravel shoals of free-flowing rivers and streams (US FWS, 2004, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
<u>Mussel, scaleshell (Leptodea leptodon)</u>	The scaleshell habitat is composed of riffles and runs in medium to large rivers with low to medium gradients and slow to moderate velocity of current. It inhabits a variety of substrates from gravel to mud, but riffles are primarily stable (US FWS, 2010, p.18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/100407_v2.pdf
<u>Mussel, sheepnose (Plethobasus cyphus)</u>	The sheepnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and boulders. Sheepnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
<u>Mussel, snuffbox (Epioblasma triquetra)</u>	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Federal Register Notice: Listing. http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27413.pdf#page=2 USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf

Species	Habitat	Rationale	Source
<u>Pearlshell</u> , <u>Louisiana</u> (<u>Margaritifera</u> <u>hembeli</u>)	Specific habitat requirements are not known. This species apparently requires a free-flowing stream (US FWS, 1990, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/901203.pdf
<u>Pearlymussel</u> , <u>birdwing</u> (<u>Lemiox</u> <u>rimosus</u>)	This species is most often observed in clean fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. It is usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060206a.pdf
<u>Pearlymussel</u> , <u>cracking</u> (<u>Hemistena</u> <u>lata</u>)	The cracking pearlymussel has undergone a substantial range reduction. It was historically distributed in the Ohio, Cumberland, and Tennessee River systems. The species has been extirpated throughout much of its range. It was last collected from Mussel Shoals, an 85 km reach of the Tennessee River in Alabama, prior to 1925 and is presumed to be extirpated from the shoal. It is presently known to survive at only a few shoals in the Clinch and Powell Rivers in Tennessee and Virginia, and it has likely been reduced to only three viable populations in these systems. The species possibly survives in the Green River, Kentucky,	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F01X.html

Species	Habitat	Rationale	Source
	and below Pickwick Reservoir in the Tennessee River, Tennessee as well		
<u>Pearlymussel, Curtis</u> (<u>Epioblasma florentina curtisii</u>)	The Curtis' pearlymussel has not been seen alive in over a decade. Limited to stream segments that are transitional between headwater and lowland streams reaches - shallow stable riffles (US FWS 2010, p. 3, 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
<u>Pearlymussel, dromedary</u> (<u>Dromus dromas</u>)	This species is most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
<u>Pearlymussel, littlewing</u> (<u>Pegias fabula</u>)	This species inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins (US FWS, 1989, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890922.pdf
<u>Pearlymussel, Slabside</u> (<u>Pleuroaia dolabelloides</u>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf

Species	Habitat	Rationale	Source
	finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)		
<u>Pigtoe, Cumberland (Pleurobema gibberum)</u>	This species inhabits medium-sized rivers with fast-flowing water in areas with predominately gravel, sand and cobble substratum (US FWS, 1992, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920813.pdf
<u>Pigtoe, finereyed (Fusconaia cuneolus)</u>	This species is typically a riffle species that inhabits ford and shoal areas in free-flowing streams of moderate gradient (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/fine%20rayed%20recov%20plan.pdf
<u>Pigtoe, flat (Pleurobema marshalli)</u>	Habitat is the Tombigbee River, characterized by an increasing number of sand and gravel shoals and decreasing channel size in the upper portions (US FWS, 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Pigtoe, Georgia (Pleurobema hanleyianum)</u>	This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. It also requires a host fish, which is currently unknown (US FWS, 2013, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Draft Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Hartfield%20and%20Powell%202013%20Draft%20Three%20Mollusks%20RP%20062813.pdf
<u>Pigtoe, rough (Pleurobema plenum)</u>	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf

Species	Habitat	Rationale	Source
	in sand and gravel substrates (US FWS, 1984, p. 8).		
<u>Pigtoe, shiny Entire</u> (<u>Fusconaia cor</u>)	This species is typically a riffle species, found along fords and shoals of clear, moderate to fast-flowing streams and rivers with stable substrate. It does not inhabit deep pools or impounded areas. This species is usually found well-buried in the substrate during most of the year and is more readily visible in early summer (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709d.pdf
<u>Pigtoe, southern</u> (<u>Pleurobema georgianum</u>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 59)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Pimpleback, orangefoot</u> (<u>pearlymussel</u>) (<u>Plethobasus cooperianus</u>)	The 1984 Recovery Plan indicated that the orange-foot pimpleback was known from the Tennessee, Cumberland, and lower Ohio Rivers (US FWS, 1984, p. 2). The habitat is described as medium to large rivers in sand and gravel substrates. In the Ohio River it was collected from 15-29 feet depths, but may have lived in shallower riffles (US FWS, 1984, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840930b.pdf

Species	Habitat	Rationale	Source
<u>Plover, piping except Great Lakes watershed (Charadrius melodus)</u>	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation. At inland lakes, they use barren to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).	The proposed dicamba DGA uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf
<u>Plover, piping Great Lakes watershed (Charadrius melodus)</u>	The breeding habitat of the Great Lakes DPS of the piping plover is well defined by the Critical Habitat designation. Critical Habitat for this DPS consists of approximately 200 miles of Great Lakes shoreline (extending 1640 ft inland) in 26 counties in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. Additional Critical Habitat for wintering populations of this DPS are in the southeastern United States and other areas that are outside the scope of this analysis	The proposed dicamba DGA uses are not expected to overlap with sparsely vegetated sandy shorelines or islands of the Great Lakes.	USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3009.pdf USFWS. 2000. Federal Register Notice http://ecos.fws.gov/docs/federal_register/fr3648.pdf

Species	Habitat	Rationale	Source
	(USFWS, 2000; USFWS, 2009, p.2).		
<u>Pocketbook, fat (Potamilus capax)</u>	The fat pocketbook is a large river species requiring flowing water and a stable substrate, which can vary widely but is most likely a mixture of sand, silt and clay. It occurs in water from a few inches deep to at least 8 feet. Habitat includes drainage ditches. (US FWS, 1989, p. 6). Populations have been found in larger rivers in the Ohio River system, and it may occur as deep as 20 feet (US FWS, 2012, p. 7-8). It can also tolerate periods of high suspended sediments (US FWS, 2012, p. 11).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf
<u>Pocketbook, Ouachita rock (Arkansia wheeleri)</u>	This species inhabits pools, backwaters, and side channels of rivers and large creeks in or near the southern slope of the Ouachita Uplift. This species occupies stable substrates containing gravel, sand, and other materials (US FWS, 2004. Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040602.pdf

Species	Habitat	Rationale	Source
<u>Pocketbook speckled (Lampsilis streckeri)</u>	Specific habitat requirements are not known. The species is found in coarse to muddy sand in depths up to 0.4 meters (1.3 feet) with a constant flow of water. The occurrence in areas of constant water flow suggests a requirement for well-oxygenated conditions (US FWS 1992, p. 3).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920102.pdf
<u>Purple Cat's paw (=Purple Cat's paw pearlymussel) (Epioblasma obliquata obliquata)</u>	Inhabits boulder to sandy substrates in large rivers of the Ohio River basin (US FWS 1992, Executive summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920310.pdf
<u>Rabbitsfoot (Quadrula cylindrica cylindrica)</u>	Primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity. They have been reported in deep water runs up to 12 feet depth. "Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf
<u>Rabbitsfoot, rough (Quadrula cylindrica strigillata)</u>	Inhabits medium-sized to large rivers in moderate to swift current but often exists in areas close to, but not in, the swiftest current (Gordon 1991). It is reported to live in silt, sand, gravel, or cobble in eddies at the edge of midstream currents and may be associated with	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	FWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
	macrophyte beds (Yeager and Neves 1986, Gordon 1991). The rough rabbitsfoot seldom burrows; it generally lies on its side on the stream bottom (Neves, pers. comm., 2003) (US FWS 2004, p. 19).		
<u>Riffleshell, northern</u> (<u>Epioblasma torulosa rangiana</u>)	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf
<u>Riffleshell, tan</u> (<u>Epioblasma florentina walkeri</u> (=E. <u>walkeri</u>))	This species inhabits streams described as shallow and turbid with numerous riffles and substrate consisting of loose rocks and gravel bars with an abundance of water willow (US FWS, 1984, P, 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/tan%20riffleshell%20rp.pdf
<u>Ring pink (mussel)</u> (<u>Obovaria retusa</u>)	This species inhabits gravel and sandy substrates in large rivers of the Ohio River basin (US FWS, 1991).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910325.pdf

Species	Habitat	Rationale	Source
<u>Riversnail, Anthony's (Athearnia anthonyi)</u>	This species is typically found in large streams on large submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water (US FWS, 1997).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970813.pdf
<u>Sawfish, smalltooth (Pristis pectinata)</u>	Smalltooth sawfish are tropical marine and estuarine fish that have the northwestern terminus of their Atlantic range in the waters of the eastern United States. In the United States, smalltooth sawfish are generally a shallow water fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. (US FWS NMFS, NOAA 2001, p. 19416)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS, NOAA. 2001. Federal Register Notice: Proposed Endangered Status for a DPS of Smalltooth Sawfish. http://ecos.fws.gov/docs/federal_register/fr3741.pdf
<u>Sea turtle, green (Chelonia mydas)</u>	Green turtles are primarily restricted to tropical and subtropical waters. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found from Massachusetts to Texas and in the U.S. Virgin Islands and Puerto Rico...Seagrasses are the principal dietary component of juvenile and adult green turtles throughout the Wider Caribbean region (Bjorndal, 1995). (NMFS, NOAA 1998, p. 46694)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

Species	Habitat	Rationale	Source
<u>Sculpin, grotto</u> <u>(Cottus sp.)</u>	Grotto sculpin occupy cave streams, resurgences (also known as “spring branches”) (Vandike 1985, p. 10), springs, and surface streams (Adams 2012, pers. comm.; Adams et al. 2013, pp. 491–493; Burr et al. 2001, p. 284). They occupy pools and riffles with moderate flows and variable depths (4 to 33 centimeters (cm) (1.6 to 13 in)) (Burr et al. 2001, p. 284). Although grotto sculpin have been documented to occur over a variety of substrates (for example, silt, gravel, cobble, rock rubble, and bedrock), the presence of cobble or pebble is necessary for spawning (Burr et al. 2001, p. 284; Adams et al. unpub. data; Adams et al. 2013, pp. 491–492) (US FWS 2013, p. 58928).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat (58938) http://www.gpo.gov/fdsys/pkg/FR-2013-09-25/pdf/2013-23182.pdf
<u>Sea turtle, hawksbill</u> <u>(Eretmochelys imbricata)</u>	The hawksbill turtle occurs in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Coral reefs, like those found in the waters surrounding Mona and Monito Islands, are widely recognized as the primary foraging habitat of juvenile, subadult, and adult hawksbill turtles. This habitat association is directly related to the species’ highly specific	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

Species	Habitat	Rationale	Source
	diet of sponges (Meylan, 1988). Hawksbills depend on coral reefs for food and shelter; therefore, the condition of reefs directly affects the hawksbill's well-being. (NMFS, NOAA 1998, p. 46695)		
<u>Sea turtle, Kemp's ridley (Lepidochelys kempii)</u>	This life history pattern is characterized by three basic ecosystem zones: (1) Terrestrial zone (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) Neritic zone - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2011, p. I-8)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2011. Bi-national recovery plan for the kemp's ridley sea turtle. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

Species	Habitat	Rationale	Source
<u>Sea turtle, leatherback (Dermochelys coriacea)</u>	Leatherbacks are able to take advantage of a wide variety of marine ecosystems (reviewed by Saba 2013; see NOAA large marine ecosystem website: http://www.lme.noaa.gov/). Within these ecosystems, various oceanic features such as water temperature, downwelling, Ekman upwelling, sea surface height, chlorophyll-a concentration, and mesoscale eddies affect the presence of leatherbacks (Bailey et al. 2013; Benson et al. 2011). The physical characteristics observed within these marine ecosystems also affect the distribution and abundance of leatherback prey (reviewed by Saba 2013). (NMFS, NOAA 2013, p. 20-22).	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2013. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/090116.pdf
<u>Sea turtle, loggerhead Northwest Atlantic DPS (Caretta caretta)</u>	The three basic ecosystems in which loggerheads live are the: 1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur. 2. Neritic zone - the nearshore marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters. The neritic zone generally includes the	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2009. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

Species	Habitat	Rationale	Source
	<p>continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the neritic zone conventionally extends to areas where water depths are less than 200 meters.</p> <p>3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2009, p. I-20)</p>		
<u>Shiner,</u> <u>Arkansas River</u> <u>(Notropis</u> <u>girardi)</u>	<p>Wilde et al. (2000) found no obvious selection for or avoidance of any particular habitat type (i.e., main channel, side channel, backwaters, and pools) by Arkansas River shiner. Arkansas River shiners did tend to select side channels and backwaters slightly more than expected based on the availability of these habitats (Wilde et al. 2000). Likewise, they appeared to make no obvious selection for, or avoidance of, any particular substrate type. Substrates (i.e., the river bed) in the Canadian River in New Mexico and Texas were predominantly sand, however, the Arkansas River shiner was observed to occur over silt slightly more than expected based on the availability of this substrate (Wilde et al.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>US FWS. 2005. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/recovery_plan/950830.pdf</p>

Species	Habitat	Rationale	Source
	2000) ; preferred habitat for the Arkansas River shiner is the mainstem of larger plains rivers... historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin (Gilbert 1980). Adults are uncommon in quiet pools or backwaters lacking streamflow, and almost never occurred in habitats having deep water and bottoms of mud or stone (Cross 1967) (US FWS 2005).		
<u>Shiner, blue</u> <u>(Cyprinella</u> <u>caerulea)</u>	The blue shiner primarily occupies second to fourth order, moderate gradient streams within the Ridge and Valley and Piedmont physiographic provinces of Alabama, Georgia, and Tennessee (Smith-Vaniz 1968, Ramsey 1976, Krotzer 1984, Ramsey and Pierson 1986, Pierson and Krotzer 1987, Mayden 1989, Pierson et al. 1989, Boschung 1992, Etnier and Starnes 1993, Dobson 1994). Most watersheds where it is found are predominately forested, and agriculture and urban development are minimal. For example in Alabama, land cover in the Choccolocco watershed is 66 percent forest, 20 percent pasture, and 13 percent agriculture...It prefers a	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950830.pdf

Species	Habitat	Rationale	Source
	sand or sand and gravel substrate sometimes with cobble, low to moderate velocity current, and a depth of about 0.15 to 1 meters (0.5 to 3 feet) (Gilbert et al. 1979; Krotzer 1984, Pierson and Krotzer 1987, Dobson 1994) (US FWS 1995, p. 3-4)		
<u>Shiner, Topeka</u> (<u>Notropis topeka</u> (=tristis))	Topeka shiners are typically found in small, low order, prairie streams with good water quality, relatively cool temperatures, and low fish diversity. Although Topeka shiners can tolerate a range of water temperatures, cooler, spring-maintained systems are considered optimal. These streams generally maintain perennial flow but may become intermittent during summer or periods of drought, as long as there are refuge areas in headwaters springs or main channels of larger streams that do not provide adequate year-round habitat. While headwaters, oxbows and side channels provide the typical habitat, mainstem streams provide for dispersal as well as for	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/five_year_review/doc2585.pdf

Species	Habitat	Rationale	Source
	<p>drought refuge. The shiner is very often associated with groundwater discharges. Substrates are typically clean gravel, cobble, or sand, but may include bedrock and clay hardpan covered by a thin layer of silt, or coarse sand overlain by silt and detritus. Spawning is often over native sunfish nests (US FWS, 2004, pp, 44743-4).</p>		
<p><u>Snail, Iowa Pleistocene (Discus macclintocki)</u></p>	<p>The Iowa Pleistocene snail only occurs on high quality algific (cold producing) talus slopes with temperatures ranging from 35-45 degrees Fahrenheit. Air flows through fractured bedrock, over frozen groundwater, and out-vents on steep slopes to create a cold microclimate. These are talus covered slopes with thin soil that makes them extremely fragile and sensitive to disturbance, and irreplaceable. This habitat is known only to occur in the "driftless area" that overlaps where the states of Illinois, Iowa, Minnesota, and Wisconsin come together (US FWS, 2009, p. 11). All known areas are north-facing slopes, and the</p>	<p>The proposed dicamba DGA uses are not expected to overlap with algific talus slopes.</p>	<p>USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840322.pdf</p> <p>USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc2585.pdf</p>

Species	Habitat	Rationale	Source
	ground temperature seldom exceeds 50 degrees Fahrenheit even in the hottest summers (US FWS, 1984, p. 5).		
<u>Snail, painted snake coiled forest (Anguispira picta)</u>	This species is limited to Buck Creek Cove. It is found only in limestone outcrops in parts of the cove with good cover. The slopes of the cove are very steep with crock outcrops and sheer cliffs at intervals along both sides of the creek (US FWS, 1982).	The proposed dicamba DGA uses are not expected to overlap with creeks or stone outcrops along creeks.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060206.pdf
<u>Snake, copperbelly water (Nerodia erythrogaster neglecta)</u>	Copperbellies are generally affiliated with wetlands and prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (Cephalanthus occidentalis), emergent wetlands, or the margins of palustrine open water wetlands. Buttonbrush swamps are used as basking areas. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Uplands are also important. (US FWS, 2008, p. 17-18). Critical Habitat has not been designated for the snake because of concerns related to illegal collection (US FWS, 2008, p. 20).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2008. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/081223.pdf

Species	Habitat	Rationale	Source
<u>Spectaclecase (mussel)</u> <u>(Cumberlandia monodonta)</u>	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
<u>Spider. spruce-fir moss</u> <u>(Microhexura montivaga)</u>	Typical habitat appears to be associated with moist, well-drained moss mats growing on rocks and boulders in well-shaded situations in mature high-elevation conifer forests dominated by Fraser fir, <i>Abies fraseri</i> , often with scattered red spruce, <i>Picea rubens</i> . (US FWS 1998, p. iii)	The proposed dicamba DGA uses are not expected to overlap with high-elevation conifer forests.	US FWS, 1998, Recovery Plan. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
<u>Squirrel, Carolina northern flying</u> <u>(Glaucomys sabrinus coloratus)</u>	Species composition of the occupied forest may vary in different locations, some combination of hardwoods and conifers (particularly spruce and fir) appears essential to support these animals...Food sources for the Carolina northern flying squirrel include fungi, lichens, staminate cones, insects, and other animal matter (US FWS 1990, p. 6-7)	The proposed dicamba DGA uses are not expected to overlap with hardwood and conifer forests.	USFWS. 1990. Recovery Plan for Appalachian Northern Flying Squirrels. United States Fish and Wildlife Service.

Species	Habitat	Rationale	Source
<u>Stirrupshell</u> (<u>Quadrula</u> <u>stapes</u>)	Habitat is the Tombigbee River, characterized by an increasing number of sand and gravel shoals and decreasing channel size in the upper portions (US FWS, 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Sturgeon, gulf</u> (<u>Acipenser</u> <u>oxyrinchus</u> <u>desotoi</u>)	The Gulf sturgeon is an Anadromous fish which migrates from salt water into large coastal rivers to spawn and spend the warm months. The majority of its life is spent in fresh water (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950922.pdf
<u>Sturgeon, pallid</u> (<u>Scaphirhynchus</u> <u>albus</u>)	Habitat is the bottom in swift waters of large, turbid, free-flowing rivers, often over sand substrates, but other substrates include at least gravel and rock. Sloughs, chutes, and side channels that transition from floodplain to the main channels are apparently important as spawning, nursery, and feeding areas. Within the subject states, this habitat occurs in the Mississippi and Missouri rivers (US FWS, 1993, pp 6-7). Within this habitat, they tend to select main channel habitats in the Mississippi River, and main channel habitats with islands or sand bars in the upper Missouri River (US FWS, 2007, p. 8). They do not typically occur in impounded areas due	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Pallid%20Sturgeon%20Recovery%20Plan%20First%20Revision%20signed%20version%20012914_3.pdf USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1059.pdf

Species	Habitat	Rationale	Source
	to lower flows and other hydrologic factors, nor where channel stabilization has reduced channel meandering and access to floodplain areas (US FWS, 2007, p. 38).		
<u>Tern, least interior pop. (Sterna antillarum)</u>	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting occurs along river banks (US FWS, 1990, p. 20).	The proposed dicamba DGA uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf

Species	Habitat	Rationale	Source
<u>Tiger beetle, Salt Creek (Cicindela nevadica lincolniana)</u>	Very specific habitat requirements and occurs in saline wetlands—on exposed saline mud flats or along mud banks of streams and seeps that contain salt deposits and are sparsely vegetated (Carter 1989; Spomer and Higley 1993; LaGrange 1997; Spomer et al. 2004a). Larvae have been found only on moist salt flats and salt-encrusted banks of Little Salt Creek in northern Lancaster County (Spomer et al. 2004a) and saline wetlands associated with Rock Creek in the southern margin of Saunders County. Salt Creek tiger beetles require open, barren salt flat areas (US FWS 2009, p. 2).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	US FWS, 2009, Recovery Outline for the Salt Creek tiger beetle (2)
<u>Turtle, ringed map (Graptemys oculifera)</u>	Rivers and adjacent white sand beaches with basking sites (brush, logs debris) (USACE)	The proposed dicamba DGA uses are not expected to overlap with rivers or beaches.	USACE. Ringed Map Turtle Species Profile. US Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory.
<u>Turtle, yellow-blotched map (Graptemys flavimaculata)</u>	Rivers and large creeks, prefers moderate currents, abundant basking sites, and sandbars (US FWS 1993, p. 2)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies and their associated beaches.	USFWS. 1993. Recovery Plan for the Yellow-blotched Map Turtle. United States Fish and Wildlife Service
<u>Vireo, black-capped (Vireo atricapilla)</u>	This species is an insect-eating, migratory songbird. They arrive in Texas from mid-March to mid-April, while those in Oklahoma arrive approximately 10 days later. Breeding	The proposed dicamba DGA uses are not expected to overlap with shrublands associated with rocky gullies, edges of ravines, or eroded slopes.	USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1073.pdf USFWS. 1991. Recovery Plan.

Species	Habitat	Rationale	Source
	<p>habitat is quite variable across its range, but is generally shrublands with a distinctive patchy structure. The shrub vegetation is mostly deciduous and generally extends from the ground to about six feet above ground and covers about 30 to 60% of the total area. Open grassland separates the clumps of shrubs. (US FWS 2007, p. 7)</p> <p>From Oklahoma through most of Texas, this type of vegetational configuration occurs most frequently on rocky substrates with shallow soils, in rocky gullies, on edges of ravines, and on eroded slopes. (US FWS 1991, p. 20)</p>		http://ecos.fws.gov/docs/recovery_plan/910930h.pdf
Kirtland's Warbler (Setophaga kirtlandii)	<p>Kirtland's warblers generally occupy jack pine stands that are 5-23 years old and at least 30 acres in size. Stands with less than 20% canopy over are rarely used for nesting. Occupied stands usually occur on dry, excessively drained and nutrient poor glacial outwash sands. They are structurally homogenous with trees ranging from 1.7-5.0 m in height (US FWS, 2012, p. 24). Species is migratory and mobile species and breeding areas are found in Wisconsin.</p>	<p>The proposed dicamba DGA salt uses are not expected to overlap with jack pine stands.</p>	<p>USFWS. 2012. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4045.pdf</p>

Species	Habitat	Rationale	Source
<u>Wartyback, white (pearlymussel) (Plethobasus cicatricosus)</u>	The white wartyback has undergone a substantial range reduction and is considered to be possibly extinct. It was historically distributed in the Wabash, Ohio, Kanawha, Cumberland, Holston, and Tennessee Rivers of the Ohio, Cumberland, and Tennessee River systems; however, no live specimens have been recovered from these drainages since the early 1900s). The white wartyback may still exist in a short reach of the Tennessee River below Pickwick Dam. No living populations have been found in numerous surveys conducted in the Tennessee River since the 1960s; however, fresh dead specimens were collected in 1979 and 1982 below Pickwick Dam near Savannah, Tennessee. If this species still exists, the viability of remaining populations is extremely threatened. The white wartyback is a riffle species that is typically found in large rivers in gravel substrates.	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	USFWS, 1984, Recovery Plan White Warty-backed Pearlymussel http://ecos.fws.gov/docs/recovery_plan/060313h.pdf http://ecos.fws.gov/docs/life_histories/F00M.html
<u>Whale, finback (Balaenoptera physalus)</u>	Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm

Species	Habitat	Rationale	Source
	less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally.		
<u>Whale, humpback (Megaptera novaeangliae)</u>	<p>During migration, humpbacks stay near the surface of the ocean.</p> <p>While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.</p> <p>Humpback feeding grounds are in cold, productive coastal waters.</p>	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm
<u>Woodpecker, red-cockaded Entire (Picoides borealis)</u>	<p>Habitat: Forest, Savannah (open pine woodlands and savannahs with large old pines) (US FWS 2003, p. x)</p> <p>Habitat size (home range): 116 – 357 acres (US FWS 2003, p. 49)</p>	Proposed dicamba DGA uses are not expected to overlap with forest or savannah.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf
Plants			
<u>Aster, decurrent false (Boltonia decurrens)</u>	The natural habitat of the aster was the shores of lakes and the banks of streams including the Illinois River. It appears to require abundant light. It presently grows in such	The proposed dicamba DGA uses are not expected to overlap with the shores of lakes/streams or other floodplain habitats where the aster may occur.	<p>USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900928c.pdf</p> <p>USFWS. 2012. 5-Year-Review.</p>

Species	Habitat	Rationale	Source
	habitats but is more common in disturbed lowland areas where it appears to be dependent on human activity for survival (US FWS, 1990, p. 3). It occupies unimpounded floodplain habitats along the Illinois River system; the plant relies on periodic flood pulses to maintain populations and suitable habitat (US FWS, 2012, p. 7).		http://ecos.fws.gov/docs/five_year_review/doc4044.pdf
<u>Aster, Ruth's golden</u> (<u>Pityopsis ruthii</u>)	This species grows only in the cracks or crevices found in phyllite or graywacke boulders along the banks of or within the Ocoee and Hiwassee Rivers (US FWS, 1992).	The proposed dicamba DGA uses are not expected to overlap with rivers.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920611.pdf
<u>Avens, spreading</u> (<u>Geum radiatum</u>)	This species grows in full sun on the shallow acidic soils of high-elevation cliffs, rocky outcrops, steep slopes, and on gravelly talus (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with high-elevation cliffs, rocky outcrops, steep slopes or gravelly talus.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930428.pdf
<u>bladderpod, Missouri</u> (<u>Physaria filiformis</u>)	This species grows in shallow soils on limestone glades and outcrops in pastures and rarely in rocky open woods. Grows in shallowest soils with other annuals where bare soil occurs and few perennials are present. Burlington limestone of Mississippian age (US FWS, 1998).	The proposed dicamba DGA uses are not expected to overlap with pasture outcrops and rocky open wooded areas.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/880407.pdf
<u>Bluet, Roan Mountain</u> (<u>Hedyotis purpurea</u> var. <u>montana</u>)	This species grows in shallow soils and crevices of cliffs and outcrops and on thin rocky soils of grassy balds (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with cliffs and outcrops.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960513.pdf

Species	Habitat	Rationale	Source
<u>Bush-clover, prairie</u> (<u>Lespedeza leptostachya</u>)	The prairie bush clover occurs on both undisturbed and disturbed sites over sandy, loam, or gravelly soils included at the thin margins near rock outcrops. Sites may have been previously mowed, burned or grazed (US FWS, 1988, p. 7-8).	The proposed dicamba DGA uses are not expected to overlap with prairies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/881006.pdf
<u>Butterfly plant, Colorado</u> (<u>Gaura neomexicana</u> var. <u>coloradensis</u>)	This species requires early- to mid-succession riparian habitat. It commonly occurs in habitat types that are usually intermediate in moisture between wet, streamside communities dominated by sedges, rushes, and cattails, and dry, upland short-grass prairie. Typically, Colorado butterfly plant habitat is open, without dense or overgrown vegetation (US FWS, 2010).	The proposed dicamba DGA uses are not expected to overlap with riparian habitat or upland prairies.	USFWS. 2010. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Colorado%20Butterfly%20Plant%20Recovery%20Outline_Final_May%202010.pdf
<u>Chaffseed, American</u> (<u>Schwalbea americana</u>)	Habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with pine flatwoods, fire-maintained savannas, wetland or sedge dominated systems.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950929c.pdf
<u>Clover, running buffalo</u> (<u>Trifolium stoloniferum</u>)	Running buffalo clover occurs in mesic habitats of partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions	The proposed dicamba DGA uses are not expected to overlap with mesic habitats where the clover is expected to be found.	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

Species	Habitat	Rationale	Source
	underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).		
<u>Daisy, Lakeside (Hymenoxys herbacea)</u>	Although historical habitats include outcrops of dolomite or limestone bedrock, dry, gravelly prairies on terraces or hills associated with major river systems, rocky shores, sandy fields and alvars, the Lakeside daisy in the U. S. is now restricted to dry, thin-soiled, degraded prairies in which limestone or dolomite bedrock is at or near the surface. Habitats are alkaline, seasonally wet in spring and fall, and are moderately to extremely droughty in summer. Typically, habitats have little topographic relief, are relatively open at the	The proposed dicamba DGA uses are not expected to overlap with quarries and dry prairies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf

Species	Habitat	Rationale	Source
	ground surface, and vegetation density and diversity are relatively low. Within these habitats, lakeside daisy occurs in open patches of ground, occupies the dry to mesic portions of the soil moisture continuum and has a highly aggregated distribution. This species is either absent or infrequently found in shaded or densely vegetated areas (US FWS, 1990, pp. 20-21).		
<u>Fern, American hart's-tongue (Asplenium scolopendrium var. americanum)</u>	Early successional habitats Northern populations occur in forests of secondary growth where canopy openings are abundant. New York populations occur in conifer forests. Bryophyte beds are an important substrate.	The proposed dicamba DGA uses are not expected to overlap early successional forests, conifer forests or bryophyte beds where the species is found.	http://ecos.fws.gov/docs/recovery_plan/930915.pdf
<u>Geocarpon minimum (No common name)</u>	This species grows on sandstone glades and outcrops as well as bare, sparsely vegetated areas where the soil contains relatively large amounts of magnesium and sodium salts (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with the sandstone glades and outcrops where this species is expected to be found.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930726.pdf
<u>Goldenrod, Blue Ridge (Solidago spithamea)</u>	This species grows on rock outcrops and vertical to near vertical cliffs in southern Appalachians of western North Carolina and extreme eastern TN. Rocky summits and cliffs usually appear as smaller-scale patchy habitats embedded in larger forest consisting of	The proposed dicamba DGA uses are not expected to overlap with rock outcrops and vertical cliffs.	USFWS. 1987. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/blueridge%20goldenrod%20rp.pdf

Species	Habitat	Rationale	Source
	spruce-fir or northern hardwoods or occasionally high elevation red oak forest (US FWS, 1987).		
Goldenrod, Short's (Solidago shortii)	The habitat of Short's goldenrod is open areas in full sun or partial shade. Known occurrences are in limestone cedar glades, open eroded areas, edges, of open oak-hickory woods, cedar thickets, pastures, old fields, power line rights-of-way and rock ledges along rights-of-way. Cedar glades and woodland edges appear to be the natural habitat. Short's goldenrod was known historically and currently only from Kentucky when the Recovery Plan was written in 1988 (US FWS, pp. 3-4). An Indiana occurrence was located in 2001 along the Blue River in riparian habitat (US FWS, 2007, p. 6).	The proposed dicamba DGA salt uses are not expected to overlap with glades, woodland edges, pastures, or other habitat favorable for goldenrod growth.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/shortsgrodRP.pdf USFWS. 2007. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc1609.pdf
<u>Grass, Tennessee yellow-eyed (Xyris tennesseensis)</u>	Xyris tennesseensis is a rare perennial monocot that is an obligate wetland plant that prefers relatively high pH seeps and streambanks. An Obligate wetland plant that is restricted to calcareous seeps, fens, and spring runs (US FWS, 2014).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2014. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4360.pdf
<u>Ground-plum, Guthrie's (=Pyne's)</u>	This species is endemic to cedar glades (US FWS, 2011).	The proposed dicamba DGA uses are not expected to overlap with cedar glades.	USFWS. 2011. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/20110722b_Pynes

Species	Habitat	Rationale	Source
<u>(Astragalus bibullatus)</u>			%20ground%20plum_RP_final_1.pdf
<u>Harperella (Ptilimnium nodosum)</u>	Harperella is known from only two locations in North Carolina. One population occurs in the Tar River in Granville County. Another population was reintroduced to the Deep River recently after the original population known from that area disappeared. This population occurs in Chatham County, but the river serves as the divide between Chatham and Lee counties (US FWS, 1991).	The proposed dicamba DGA uses are not expected to overlap with river habitats.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910305b.pdf
<u>Iris, dwarf lake (Iris lacustris)</u>	The dwarf lake iris grows along the northern shorelines of lakes Michigan and Huron in Wisconsin, Michigan and Ontario, Canada. It typically occurs in shallow soil over moist calcareous sands, gravel and beach rubble. Sunlight is one of the most critical factors to the growth and reproduction of the species and partly shaded or sheltered forest edges are optimal for sexual reproduction. Some form of disturbance is also required to maintain the forest openings that provide these partial shade conditions. The species is most often associated with shoreline coniferous forests dominated by	The proposed dicamba DGA uses are not expected to overlap with shoreline coniferous forests.	USFWS. 2013. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/DLI%20RP%20FINAL%20AUG2013_1.pdf

Species	Habitat	Rationale	Source
	northern white cedar and balsam fir. The principal limiting factor for dwarf lake iris is the availability of this suitable shoreline habitat (US FWS, 2013, pp. 6-7).		
<u>Ladies'-tresses, Ute (Spiranthes diluvialis)</u>	<p>Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to mois soils in mesic or wet meadows near springs, lakes, or perrenial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations are found in riparian woodlands. Observed to be shade-intolerant (US FWS, 1995).</p> <p>Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations als found in</p>	The proposed dicamba DGA uses are not expected to overlap with riverine, spring, or lakeside wet meadows.	<p>USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950921.pdf</p> <p>USFWS. Species Profile Page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2WA</p>

Species	Habitat	Rationale	Source
	riparian woodlands. Observed to be shade-intolerant (US FWS, Species Profile Page).		
<u>Lichen, rock gnome (Gymnoderma lineare)</u>	<p>Rock gnome lichen is primarily limited to vertical rock faces where seepage water from forest soils above flows during (and only during) very wet times. It appears the species needs a moderate amount of light, but that it cannot tolerate high-intensity solar radiation. It does well on moist, generally open, sites, with northern exposures, but needs at least partial canopy coverage where the aspect is southern or western</p> <p>Rock gnome lichen is known from the Southern Appalachian Mountains of North Carolina and South Carolina, Tennessee, and Georgia, in areas of high humidity, either at high elevations, where it is frequently bathed in fog, or in deep gorges at lower elevations.</p>	The proposed dicamba DGA uses are not expected to overlap with high elevation vertical rock faces where the species occurs.	http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html
<u>Lily, Minnesota dwarf trout (Erythronium propullans)</u>	The Minnesota dwarf trout lily is most commonly found in the lower parts of wooded north-facing slopes, and on adjacent floodplains. Sites are associated either with streams or abandoned stream channels, dominated by deciduous trees. It may	The proposed dicamba DGA uses are not expected to overlap with woodlands or floodplains.	USFWS. 1987. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/060309c.pdf

Species	Habitat	Rationale	Source
	be intolerant of shade (US FWS, 1987).		
<u>Locoweed,</u> <u>Fassett's</u> <u>(Oxytropis</u> <u>campestris var.</u> <u>chartacea)</u>	<p>Fassett's locoweed grows along the shorelines of small, landlocked, hardwater lakes where the bedrock is overlain by sandy glacial drift. Nearly all lakes with historical populations of the species are less than 15 ha in size and occur at approximately 350 m elevation. Dependent upon groundwater seepage for their water supply, most are shallow (maximum depth of a few meters) and subject to frequent, large fluctuations in water level.</p> <p>Fassett's locoweed is found along the lakes on open shoreline and, to a lesser extent, on higher ground under the partial shade of adjacent vegetation. It grows on gentle, sandgravel slopes and is absent from flat, low, mucky shorelines dominated by cattails and bulrushes. Because of periodic fluctuations in lake levels, the amount of exposed, open shoreline varies, from being virtually nonexistent during times of high water, to about 30 m wide when the water level is low. In all cases, Fassett's locoweed occurs in areas which are</p>	The proposed dicamba DGA uses are not expected to overlap with the shorelines of lakes.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910329.pdf

Species	Habitat	Rationale	Source
	completely exposed to sunlight or receive only partial shade from other species. (US FWS, 1991, pp.4-5).		
<u>Milkweed,</u> <u>Mead's</u> <u>(Asclepias</u> <u>meadii)</u>	Mead's milkweed occurs primarily in tallgrass prairie with a late successional bunch-grass structure, but also occurs in hay meadows and in thin soil glades or barrens. This plant is essentially restricted to sites that have never been plowed and only lightly grazed, and hay meadows that are cropped annually for hay (US FWS, 2003, p. 9).	The proposed dicamba DGA uses are not expected to overlap with tallgrass prairies, hay meadows, or thin soil glades or barrens.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030922b.pdf
<u>Monkshood,</u> <u>northern wild</u> <u>(Aconitum</u> <u>noveboracense)</u>	Typical habitat is shaded to partially shaded cliffs and talus slopes or in New York, also occurs in semi-shaded seepage springs at high elevation headwaters. Various bedrock types from sandstones to dolomite and others act as substrates. All habitats have a cold soil environment associated with active and continuous cold air drainage or cold ground water flowage out of the nearby bedrock. Typically cliff and talus slope populations are associated with openings or caves, often ice-filled, through which the cold air emanates (US FWS, 1983, p. 18-20).	The proposed dicamba DGA uses are not expected to overlap with cliffsides, rockfalls at cliff bases or springs associated with cold air or water.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/830923.pdf

Species	Habitat	Rationale	Source
<u>Orchid, eastern prairie fringed</u> (<u>Platanthera leucophaea</u>)	The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	The proposed dicamba DGA uses are not expected to overlap with grass or sedge-dominated plant communities.	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf
<u>Orchid, western prairie fringed</u> (<u>Platanthera praeclara</u>)	The western prairie-fringed orchid occurs primarily in tall grass prairies dominated by bluestem grass and in sedge meadows that are seasonally wet (US FWS, 1996, p. 6). They also may occur in successional communities such as borrow pits, old fields, and roadside ditches (US FWS, 1996, p. 4).	The proposed dicamba DGA uses are not expected to overlap with prairie, meadow areas, roadside ditches, borrow pits or abandoned fields.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930a.pdf
<u>Penstemon, blowout</u> (<u>Penstemon haydenii</u>)	This species grows in depressions in the topography caused by wind erosion. Vegetation associated with blowouts is distinctly different than	The proposed dicamba DGA uses are not expected to overlap with sandy slough slopes or dunes.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920717.pdf

Species	Habitat	Rationale	Source
	<p>vegetation associated with adjacent, non-eroding areas.</p> <p>In Wyoming, blowout penstemon is found primarily on the rim and lee slopes of blowouts, or the rim and steep faces of sandy slough slopes. These deposits are found at the base of mountains or ridges, which represent topographic barriers. Shifting sand dunes are prevented from becoming fully stabilized and overgrown because of wind and gravity. The dunes may be 60 to 120 feet high (US FWS, 1992).</p>		
<u>Pitcher-plant, green (Sarracenia oreophila)</u>	<p>Habitats for this species can be generally grouped into two types: stream banks (considered ephemeral) and upland bogs. Upland bogs, fire dependent, range from open to forested, underlain by semi-impervious clay layers (US FWS, 1994).</p>	The proposed dicamba DGA uses are not expected to overlap with stream banks or upland bogs.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/941212.pdf
<u>Pogonia, small whorled (Isotria medeoloides)</u>	<p>The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most</p>	The proposed dicamba DGA uses are not expected to overlap with mixed deciduous/coniferous forests.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf

Species	Habitat	Rationale	Source
	occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).		
<u>Pondberry</u> (<u>Lindera melissifolia</u>)	Associated with seasonally flooded wetlands. Found on wet edges of sandy sinks, ponds, and swampy depressions. Shade tolerant (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930923a.pdf
<u>Potato-bean</u> , <u>Price's (Apios priceana)</u>	Found in open forests along the edges of forests, creeks, and rivers (US FWS, 1993, p. executive summary).	The proposed dicamba DGA uses are not expected to overlap with forests, or water bodies.	USFWS. 1993. Recovery Plan http://ecos.fws.gov/docs/recovery_plan/930210.pdf
<u>Prairie-clover</u> , <u>leafy (Dalea foliosa)</u>	Leafy prairie-clover is found only in open limestone cedar glades, limestone barrens, and dolomite prairies which have shallow, silt to silty clay loam soils	The proposed dicamba DGA uses are not expected to overlap with prairies or areas with visible bedrock.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf

Species	Habitat	Rationale	Source
	over flat and often highly fractured, horizontally bedded limestone or dolomite with frequent expanses of exposed bedrock at surface. Elevations are typically between 550 and 700 feet. These habitats experience high surface and soil temperatures, generally have low soil moisture but are wet in the spring and fall and become droughty in summer. The distribution of glade, barren, and dry to wet dolomite prairie at any particular site varies and leads to a mosaic of soils and their associated plant communities (USFWS, 1996, p.13).		
<u>Quillwort, Louisiana (Isoetes louisianensis)</u>	This species grows in sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland. bayhead forests of fine flatwoods and upland longleaf pine (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with streams, overflow channels, or riparian woodlands.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930b.pdf
<u>Rock-cress, Braun's (Arabis perstellata)</u>	Braun's rockcress occurs on the slopes of calcareous mesophytic and sub-xeric forest types. The occurrence of this species does not appear to be limited to a particular slope aspect, elevation, or moisture regime within the slope forests. It is, however, sun intolerant and always occurs in at least partial shade. The	The proposed dicamba DGA uses are not expected to overlap with calcareous mesophytic and sub-xeric forested systems.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970722.pdf

Species	Habitat	Rationale	Source
	largest and most vigorous populations occur on moist mid- to upper slope sites. Plants are often found around rock outcrops, protected sites on the downslope side of tree bases, and sites of natural disturbance, such as talus slopes and animal trails. It is rarely found growing among the Leaf litter and herbaceous cover of the forest floor (US FWS, 1997).		
<u>Rosemary, Cumberland (Conradina verticillata)</u>	This species is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (pg. 8) (US FWS, 2011).	The proposed dicamba DGA uses are not expected to overlap with rivers.	USFWS. 2011. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3629.pdf
<u>Roseroot, Leedy's (Rhodiola)</u>	New York populations occur on cliffs along the western shore of Seneca lake. In Minnesota,	The proposed dicamba DGA uses are not expected to overlap with cliffs.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980925.pdf

Species	Habitat	Rationale	Source
<u>integrifolia ssp. leedyi</u>	populations occur on moderate cliffs, which are cooled by air exiting underground passages in the karst topography (US FWS, 1998).		
<u>Sandwort, Cumberland (Arenaria cumberlandensis)</u>	This species is restricted to sandstone rock houses, ledges, and solution pockets on sandstone rock faces; The species is found on the sandy floors of rock houses, in solution pockets on the face of sandstone cliffs, and on ledges beneath overhanging sandstone (pg. 4) (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with sandstone rock houses, ledges, or rock faces.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960620.pdf
<u>Skullcap, large-flowered (Scutellaria montana)</u>	This species occurs in slope, ravine, and stream-bottom forests in northwestern Georgia and adjacent southeastern Tennessee. Habitat loss and lack of information on appropriate management are the factors limiting the number of viable populations (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with ravine and stream-bottom forests.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960515.pdf
<u>Sneezeweed, Virginia (Helenium virginicum)</u>	Seasonal wetlands, sink hole ponds varying from forest settings to farm pond margins.	The proposed dicamba DGA uses are not expected to overlap sink hole ponds and seasonal wetlands.	http://ecos.fws.gov/docs/recovery_plan/001002.pdf

Species	Habitat	Rationale	Source
<u>Spiraea</u> , <u>Virginia</u> (<u>Spiraea</u> <u>virginiana</u>)	<i>Spiraea virginiana</i> is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-18.).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf
<u>Thistle</u> , <u>Pitcher's</u> (<u>Cirsium</u> <u>pitcheri</u>)	It occurs on non-forested sand dunes of several types (grassland dunes, simple linear beach foredunes, continuous and discontinuous dune complexes), sand beaches, and sandy blowouts, primarily occurring around the Great Lakes (US FWS, 2002, p. 23-27).	The proposed dicamba DGA uses are not expected to overlap with sand dunes, sand beaches, or sandy blowouts.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920b.pdf

Appendix 3. Designated Critical Habitat Modification Determinations

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis consistent with the Overview Document (USEPA, 2004) as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species. The Agency will conclude 'modification' of designated critical habitat if the range of designated critical habitat co-occurs with the states subject to the Federal action and one or more of the following conditions exist:

1. The available Services' information indicates that cotton or soybean fields are habitat for the species and there is a "may affect" determination for the species associated with exposure to Dicamba DGA salt or its degradate DCSA, as labeled.
2. The available Services' information indicates that the species uses cotton or soybean fields and one or more effects on taxonomic groups predicted for dicamba DGA salt or its degradate DCSA, on cotton or soybean fields would modify one or more of the designated PCEs.

If the above conditions are not met, EPA concludes 'no modification.'

Results of Analysis

Of the 183 listed species within the 16 states there are 173 species identified in the effects determinations as not using cotton or soybean fields and 10 species using these fields. Critical habitats have been designated for 59 of the 183 species. Fifty-three species with critical habitat were judged to not use cotton or soybean fields and so the critical habitat determination for these was no modification. The remaining 6 species with critical habitat designations were assumed to use cotton or soybean fields and so the previous listed species effects determinations were consulted to ascertain if any were determined to be at risk for direct adverse effects. None of the species were determined to be at risk for direct adverse effects, so the PCE's listed in the Services' critical habitat designations were consulted to determine if, in light of the screening assessment risk findings, they would be impacted by on-field exposure to dicamba DGA salt. For all but one of these species, the PCE's are not relatable to agricultural fields and so a determination of no modification has been made for these 5 species.

The only species using cotton or soybean fields and with critical habitat PCE's relatable to agricultural fields was the whooping crane, for which agricultural fields were discussed as providing waste grain as a potential food source for migratory cranes. The potential pathway for applications of dicamba DGA salt to affect this PCE is by making grain potentially toxic to the birds. Because there is unlikely to be any edible waste grain remaining following cotton harvesting, it is unlikely that the proposed dicamba DGA salt use on cotton could affect this PCE. However, the proposed use on soybean could affect this PCE by making waste soybean grain potentially toxic.

The Health Effect Division summarized available soybean grain residues of dicamba in the Human Health Risk Assessment for the Registration Eligibility Decision for Dicamba and Associated Salts (DP317703). Based on the soybean trials results, maximum residues of dicamba were 0.04 ppm in hay, 0.097 ppm in forage, and 8.13 ppm in seed 6-8 days post treatment (MRIDs 43814101 and 44089307). These measured values were used to set the tolerance value of 10 ppm for soybean seeds. The measured residues are not

reasonably expected to be at a level raising a concern for direct effects to the whooping crane because the direct effects assessment for this species (presented on pages 9-10 of this assessment) did not establish a concern for residues in other dietary items at much **higher** (~ 1 order of magnitude) concentrations than would occur at the maximum measured residues in seed or if residues were present even at the tolerance level of 10.0 ppm. Because this analysis shows no direct effects of dicamba at levels that would be expected in the fields as waste grain, an indirect effect, there is no modification of critical habitat. Similarly, measured DCSA residues in waste soybean grain (0.44 ppm) would be well below the estimated DCSA concentrations in arthropods (42.5 ppm) used in the direct effects assessment for this species (pp 9-10). Therefore, whooping crane critical habitat within the 16 states would not be modified.

Summary of Determinations for Critical Habitat

The Agency has determined that the proposed labeled use of dicamba DGA salt on cotton and soybeans will not modify designated critical habitat for the 59 species for which such habitats have been designated in AR, IL, IN, IA, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI.

Summary of listed species identified as not being on agricultural fields with and without critical habitat designations for the first 16 states assessed for dicamba DGA salt

Critical Habitat Designation	Species Name
<i>Species with Critical Habitat Designations (53 Species)²</i>	Bean, Purple (<i>Villosa perpurpurea</i>)
	Butterfly Plant, Colorado (<i>Gaura neomexicana</i> var. <i>coloradensis</i>)
	Butterfly, Karner Blue (<i>Lycaeides melissa samuelis</i>)
	Cavesnail, Tumbling Creek (<i>Antrobia culveri</i>)
	Chub, Slender (<i>Erimystax cahni</i>)
	Chub, Spotfin (<i>Erimonax monachus</i>)
	Clubshell, Ovate (<i>Pleurobema perovatum</i>)
	Clubshell, Southern (<i>Pleurobema decisum</i>)
	Combshell, Cumberlandian (<i>Epioblasma brevidens</i>)
	Combshell, Upland (<i>Epioblasma metastriata</i>)
	Dace, Laurel (<i>Chrosomus saylori</i>)
	Darter, Amber (<i>Percina antesella</i>)
	Darter, Cumberland (<i>Etheostoma susanae</i>)
	Darter, Leopard (<i>Percina pantherina</i>)
	Darter, Niangua (<i>Etheostoma nianguae</i>)
	Darter, Slackwater (<i>Etheostoma boschungii</i>)
	Darter, Snail (<i>Percina tanasi</i>)
	Darter, Yellowcheek (<i>Etheostoma moorei</i>)
	Dragonfly, Hine's Emerald (<i>Somatochlora hineana</i>)
	Elktoe, Appalachian (<i>Alasmidonta raveneliana</i>)
	Elktoe, Cumberland (<i>Alasmidonta atropurpurea</i>)
	Frog, Dusky Gopher (<i>Rana sevosa</i>)
	Kidneyshell, Fluted (<i>Ptychobranhus subtentum</i>)
	Kidneyshell, Triangular (<i>Ptychobranhus greenii</i>)
	Logperch, Conasauga (<i>Percina jenkinsi</i>)
	Lynx, Canada (<i>Lynx canadensis</i>)

² Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Critical Habitat Designation	Species Name
	Madtom, Chucky (<i>Noturus crypticus</i>)
	Madtom, Smoky (<i>Noturus baileyi</i>)
	Madtom, Yellowfin (<i>Noturus flavipinnis</i>)
	Manatee, West Indian (<i>Trichechus manatus</i>)
	Moccasinshell, Alabama (<i>Medionidus acutissimus</i>)
	Moccasinshell, Coosa (<i>Medionidus parvulus</i>)
	Mucket, Neosho (<i>Lampsilis rafinesqueana</i>)
	Mucket, Orangenacre (<i>Lampsilis perovalis</i>)
	Mussel, Oyster (<i>Epioblasma capsaeformis</i>)
	Pearlymussel, Slabside (<i>Pleuonaia dolabelloides</i>)
	Pigtoe, Georgia (<i>Pleurobema hanleyianum</i>)
	Pigtoe, Southern (<i>Pleurobema georgianum</i>)
	Plover, Piping (Great Lakes DPS, Northern Great Plains DPS) (<i>Charadrius melodus</i>)
	Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)
	Rabbitsfoot, Rough (<i>Quadrula cylindrica strigillata</i>)
	Rock-Cress, Braun's (<i>Arabis perstellata</i>)
	Sculpin, Grotto (<i>Cottus sp.</i>)
	Sea Turtle, Green (<i>Chelonia mydas</i>)
	Sea Turtle, Hawksbill (<i>Eretmochelys imbricata</i>)
	Sea Turtle, Kemp's Ridley (<i>Lepidochelys kempii</i>)
	Sea Turtle, Leatherback (<i>Dermochelys coriacea</i>)
	Sea Turtle, Loggerhead Northwest Atlantic DPS (<i>Caretta caretta</i>)
	Shiner, Arkansas River (<i>Notropis girardi</i>)
	Shiner, Topeka (<i>Notropis topeka</i> (=tristis))
	Spruce-Fir Moss Spider (<i>Microhexura montivaga</i>)
	Sturgeon, Gulf (<i>Acipenser oxyrinchus desotoi</i>)
	Tiger Beetle, Salt Creek (<i>Cicindela nevadica lincolniiana</i>)
Species without Critical Habitat Designations (123 species)	Acornshell, Southern (<i>Epioblasma othcaloogensis</i>)
	Amphipod, Illinois Cave (<i>Gammarus acherondytes</i>)
	Aster, Decurrent False (<i>Boltonia decurrens</i>)
	Aster, Ruth's Golden (<i>Pityopsis ruthii</i>)
	Avens, Spreading (<i>Geum radiatum</i>)
	Bat, Gray (<i>Myotis grisescens</i>)
	Bean, Cumberland (pearlymussel) (<i>Villosa trabalis</i>)
	Bladderpod, Missouri (<i>Physaria filiformis</i>)
	Blossom, Green (pearlymussel) (<i>Epioblasma torulosa gubernaculum</i>)
	Blossom, Tubercled (pearlymussel) (<i>Epioblasma torulosa torulosa</i>)
	Blossom, Turgid (pearlymussel) (<i>Epioblasma turgidula</i>)
	Blossom, Yellow (pearlymussel) (<i>Epioblasma florentina florentina</i>)
	Bluet, Roan Mountain (<i>Hedyotis purpurea</i> var. <i>montana</i>)
	Bush-Clover, Prairie (<i>Lespedeza leptostachya</i>)
	Butterfly, Mitchell's Satyr (<i>Neonympha mitchellii mitchellii</i>)
	Catspaw, White (<i>Epioblasma obliquata perobliqua</i>)

Critical Habitat Designation	Species Name
	Cavefish, Ozark (<i>Amblyopsis rosae</i>)
	Chaffseed, American (<i>Schwalbea americana</i>)
	Clover, Running Buffalo (<i>Trifolium stoloniferum</i>)
	Clubshell (<i>Pleurobema clava</i>)
	Clubshell, Black (<i>Pleurobema curtum</i>)
	Combshell, Southern (<i>Epioblasma penita</i>)
	Crayfish, Cave (<i>Cambarus aculabrum</i>)
	Crayfish, Cave (<i>Cambarus zophonastes</i>)
	Crayfish, Nashville (<i>Orconectes shoupi</i>)
	Dace, Blackside (<i>Phoxinus cumberlandensis</i>)
	Daisy, Lakeside (<i>Hymenoxys acaulis</i> var. <i>glabra</i> (herbacea))
	Darter, Bayou (<i>Etheostoma rubrum</i>)
	Darter, Bluemask (=jewel) (<i>Etheostoma</i> sp.)
	Darter, Boulder (<i>Etheostoma wapiti</i>)
	Darter, Duskytail (<i>Etheostoma percnurum</i>)
	Disc, Iowa Pleistocene (<i>Discus macclintocki</i>)
	Fanshell (<i>Cyprogenia stegaria</i>)
	Fatmucket, Arkansas (<i>Lampsilis powellii</i>)
	Fern, American Hart's-Tongue (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)
	Ferret, Black-Footed (<i>Mustela nigripes</i>)
	<i>Geocarpon minimum</i> (No common name)
	Goldenrod, Blue Ridge (<i>Solidago spithamea</i>)
	Goldenrod, Short's (<i>Solidago shortii</i>)
	Grass, Tennessee Yellow-Eyed (<i>Xyris tennesseensis</i>)
	Ground-Plum, Guthrie's (=Pyne's) (<i>Astragalus bibullatus</i>)
	Harperella (<i>Ptilimnium nodosum</i>)
	Heelsplitter, Alabama (=inflated) (<i>Potamilus inflatus</i>)
	Hellbender, Ozark (<i>Cryptobranchus alleganiensis bishopi</i>)
	Higgins Eye Pearlymussel (<i>Lampsilis higginsii</i>)
	Iris, Dwarf Lake (<i>Iris lacustris</i>)
	Lampmussel, Alabama (<i>Lampsilis virescens</i>)
	Lichen, Rock Gnome (<i>Gymnoderma lineare</i>)
	Lilliput, Pale (pearlymussel) (<i>Toxolasma cylindrellus</i>)
	Lily, Minnesota Dwarf Trout (<i>Erythronium propullans</i>)
	Locoweed, Fassett's (<i>Oxytropis campestris</i> var. <i>chartacea</i>)
	Madtom, Neosho (<i>Noturus placidus</i>)
	Madtom, Pygmy (<i>Noturus stanauli</i>)
	Madtom, Scioto (<i>Noturus trautmani</i>)
	Marstonia, Royal (snail) (<i>Pyrgulopsis ogmorhapse</i>)
	Milkweed, Mead's (<i>Asclepias meadii</i>)
	Monkeyface, Appalachian (pearlymussel) (<i>Quadrula sparsa</i>)
	Monkeyface, Cumberland (pearlymussel) (<i>Quadrula intermedia</i>)
	Monkshood, Northern Wild (<i>Aconitum novoboarense</i>)
	Mucket, Pink (pearlymussel) (<i>Lampsilis abrupta</i>)
	Mussel, Mapleleaf Winged (<i>Quadrula fragosa</i>)
	Mussel, Scaleshell (<i>Leptodea leptodon</i>)

Critical Habitat Designation	Species Name
	Mussel, Sheepnose (<i>Plethobasus cyphus</i>)
	Mussel, Snuffbox (<i>Epioblasma triquetra</i>)
	Orchid, Western Prairie White-fringed (<i>Platanthera praeclara</i>)
	Orchid, Eastern Prairie White-fringed (<i>Platanthera leucophaea</i>)
	Pearlshell, Louisiana (<i>Margaritifera hembeli</i>)
	Pearlymussel, Birdwing (<i>Lemiox rimosus</i>)
	Pearlymussel, Cracking (<i>Hemistena lata</i>)
	Pearlymussel, Curtis (<i>Epioblasma florentina curtisii</i>)
	Pearlymussel, Dromedary (<i>Dromus dromas</i>)
	Pearlymussel, Fat Pocketbook (<i>Potamilus capax</i>)
	Pearlymussel, Littlewing (<i>Pegias fabula</i>)
	Penstemon, Blowout (<i>Penstemon haydenii</i>)
	Pigtoe, Cumberland (<i>Pleurobema gibberum</i>)
	Pigtoe, Finerayed (<i>Fusconaia cuneolus</i>)
	Pigtoe, Flat (<i>Pleurobema marshalli</i>)
	Pigtoe, Rough (<i>Pleurobema plenum</i>)
	Pigtoe, Shiny (<i>Fusconaia cor</i>)
	Pimpleback, Orangefoot (<i>Plethobasus cooperianus</i>)
	Pitcher-Plant, Green (<i>Sarracenia oreophila</i>)
	Pocketbook, Ouachita Rock (<i>Arkansia wheeleri</i>)
	Pocketbook, Speckled (<i>Lampsilis streckeri</i>)
	Pogonia, Small Whorled (<i>Isotria medeoloides</i>)
	Pondberry (<i>Lindera melissifolia</i>)
	Potato-Bean, Price's (<i>Apios priceana</i>)
	Prairie-Clover, Leafy (<i>Dalea foliosa</i>)
	Purple Cat's Paw (<i>Epioblasma obliquata obliquata</i>)
	Quillwort, Louisiana (<i>Isoetes louisianensis</i>)
	Rayed Bean (<i>Vilosa fabalis</i>)
	Riffleshell, Northern (<i>Epioblasma torulosa rangiana</i>)
	Riffleshell, Tan (<i>Epioblasma florentina walkeri</i> (= <i>E. walkeri</i>))
	Ring Pink (mussel) (<i>Obovaria retusa</i>)
	Riversnail, Anthony's (<i>Athearnia anthonyi</i>)
	Rosemary, Cumberland (<i>Conradina verticillata</i>)
	Roseroot, Leedy's (<i>Rhodiola integrifolia</i> ssp. <i>leedyi</i>)
	Sandwort, Cumberland (<i>Arenaria cumberlandensis</i>)
	Sawfish, Smalltooth (<i>Pristis pectinata</i>)
	Shiner, Blue (<i>Cyprinella caerulea</i>)
	Skullcap, Large-Flowered (<i>Scutellaria montana</i>)
	Snail, Painted Snake Coiled Forest (<i>Anguispira picta</i>)
	Sneezeweed, Virginia (<i>Helenium virginicum</i>)
	Spectaclecase Mussel (<i>Cumberlandia monodonta</i>)
	Spiraea, Virginia (<i>Spiraea virginiana</i>)
	Squirrel, Carolina Northern Flying (<i>Glaucomys sabrinus coloratus</i>)
	Stirrupshell (<i>Quadrula stapes</i>)
	Sturgeon, Pallid (<i>Scaphirhynchus albus</i>)

Critical Habitat Designation	Species Name
	Tern, Least (<i>Sterna antillarum</i>)
	Thistle, Pitcher's (<i>Cirsium pitcheri</i>)
	Turtle, Ringed Map (<i>Graptemys oculifera</i>)
	Turtle, Yellow-Blotched Map (<i>Graptemys flavimaculata</i>)
	Ute, Ladies'-Tresses, (<i>Spiranthes diluvialis</i>)
	Vireo, Black-Capped (<i>Vireo atricapilla</i>)
	Warbler, Kirtland's (<i>Dendroica kirtlandii</i>)
	Wartyback, White (pearlymussel) (<i>Plethobasus cicatricosus</i>)
	Watersnake, Northern Copperbelly (<i>Nerodia erythrogaster neglecta</i>)
	Whale, Finback (<i>Balaenoptera physalus</i>)
	Whale, Humpback (<i>Megaptera novaeangliae</i>)
	Woodpecker, Red-Cockaded (<i>Picoides borealis</i>)

Summary of listed species identified as being on agricultural fields with and without critical habitat designations for the first 16 states assessed for dicamba DGA salt:

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species with Critical Habitat Designations (6 Species)</i>³		
Bat, Indiana (<i>Myotis sodalis</i>)	PCE: Shelter during winter hibernation. Critical habitat designations are either mines or caves.	http://ecos.fws.gov/docs/federal_register/fr161.pdf http://ecos.fws.gov/docs/federal_register/fr83.pdf
Bat, Ozark (<i>Corynorhinus townsendii ingens</i>)	PCE: Not specified. Critical habitat designations are caves.	http://ecos.fws.gov/docs/federal_register/fr171.pdf
Bear, Louisiana Black (<i>Ursus americanus luteolus</i>)	PCE: Habitat components that provide: (i) Breeding habitat (i.e., within or contiguous to the home range of females in a core breeding population) consisting of hardwood forest areas having a diversity of age class and species and containing sources of hard mast (acorns and nuts) produced by such species as mature oaks, hickories, and pecan, and that may include one or more of the following: (A) Areas containing soft mast provided by a diversity of plant species, including, but not limited to, blackberry, grape, mulberry, sassafras, paw paw, etc., occurring primarily in forest openings, on spoil banks, and in areas adjacent to forested habitat. (B) Areas within forested habitat providing protein sources consisting of beetles and other colonial insects found in rotting and decaying wood found on the forest floor.	http://www.gpo.gov/fdsys/pkg/FR-2009-03-10/pdf/E9-4536.pdf#page=1

³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Species Name	Primary Constituent Elements (PCE)	Source
	<p>(C) Grasses and sedges found in forest openings, on spoil banks with open canopies, and in vegetated areas adjacent to forested habitats.</p> <p>(D) Secure areas for reproduction, winter dormancy, day bedding, and escape. These include areas with den trees (e.g., bald cypress, overcup oak, American sycamore, etc.); areas with a thick understory, shrub-scrub habitat, openings along spoil banks, vegetated areas adjacent to forests, or any vegetation that provides cover, limits visibility, slows foot travel, or creates noise when traversed; early successional forests (0 to 12 years) with an open canopy and dense understory of shrubs, vines, and saplings; or areas with vegetation such as palmetto, greenbriars, blackberry, dewberry, and downed trees.</p> <p>(ii) Corridors consisting of:</p> <p>(A) Habitat patches 12 acres (5 hectares) or greater in size; or</p> <p>(B) Forested areas greater than 150 feet (46 meters) wide along waterways and sloughs and having a diversity of plant species and age-classes of sufficient area, quality, and configuration, as described in paragraph (2)(i) of this entry, to provide dispersal habitat between breeding populations to maintain genetic variability and promote stable or increasing populations, and to provide habitat supporting safe movement, foraging, and denning.</p>	
Crane, Mississippi Sandhill (<i>Grus canadensis pulla</i>)	PCE: Not specified.	http://ecos.fws.gov/docs/federal_register/fr150.pdf
Crane, Whooping (<i>Grus Americana</i>)	<p>PCE: All areas proposed in this rule would provide food, water, and other nutritional or physiological needs of the whooping crane during spring or fall migration. (1) Insects, crayfish, frogs, small fish, and other small animals as well as some aquatic vegetation and some cereal crops in adjacent croplands appear to be major items taken during the migration period. Consumption of some cereal crops in adjacent croplands during migration period. (2) Require an open expanse for nightly rooting, especially sand and gravel bars or very shallow water in rivers and lakes. (3) Whooping cranes are territorial and require several acres of undisturbed wetlands. (4) Potential nesting habitat.</p>	http://ecos.fws.gov/docs/federal_register/fr237.pdf http://ecos.fws.gov/docs/federal_register/fr214.pdf
Wolf, Gray (<i>Canis lupis</i>)	PCE: Not specified.	http://ecos.fws.gov/docs/federal_register/fr186.pdf

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species without critical habitat designations (4 species)</i>		
Beetle, American burying (<i>Nicrophorus americanus</i>)	No critical habitat rules have been published.	n/a
Bladderpod, Spring Creek (<i>Lesquerella perforata</i>) ⁴	No critical habitat rules have been published.	n/a
Prairie-chicken, Lesser (<i>Tympanuchus pallidicinctus</i>)	No critical habitat rules have been published.	n/a
Tortoise, Gopher (<i>Gopherus polyphemus</i>)	No critical habitat rules have been published.	n/a

⁴ Bold text indicates assessed species with “may effect, likely to adversely affect” determination.

Appendix 4. Foliar Half-Life Calculations

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
0.5 lb/A application					
DMA+ Salt	FL	0	71	SFO	8.98
	FL	7	35		
	FL	14	26		
	FL	28	11		
	FL	56	0.53		
	GA	0	78	TR IORE	2.89
	GA	7	10		
	GA	14	7.1		
	GA	28	1.5		
	GA	56	0.3		
	IN	0	69	TR IORE	8.46
	IN	7	15		
	IN	14	16		
	IN	28	4.6		
	IN	56	3		
	KS	0	81	TR IORE	6.16
	KS	7	25		
	KS	14	11		
	KS	28	6.5		
	KS	56	2.5		
	MI	0	27	TR IORE	4.69
	MI	7	6.9		
	MI	14	3		
	MI	28	1		
	MI	56	0.8		
	MO	0	20	SFO	7.03
	MO	7	10		
	MO	14	4.2		
	MO	28	2.6		
	MO	56	1.8		
	NE	0	28	SFO	5.13
	NE	7	12		
	NE	14	2.7		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	NE	28	1.3	SFO	2.98
	NE	56	0.64		
	OK 1	0	41		
	OK 1	7	8		
	OK 1	14	1.7		
	OK 1	28	0.79		
	OK 1	56	0.75		
	OK 2	0	61	TR IORE	5.58
	OK 2	7	15		
	OK 2	14	11		
	OK 2	28	1.8		
	OK 2	56	1.2		
	OR	0	31	TR IORE	1.14
	OR	7	2		
	OR	14	3.6		
	OR	28	3.7		
	OR	56	1.3		
	TN	0	20	TR IORE	3.18
	TN	7	2.2		
	TN	14	2.5		
	TN	28	0.71		
	TN	56	0.74		
	TX	0	35	SFO	4.42
	TX	7	11		
	TX	14	4.5		
	TX	28	1.9		
	TX	56	3.2		
	WI	0	39	TR IORE	4.3
	WI	7	9		
	WI	14	4.3		
	WI	28	1		
	WI	56	0.74		
DGA+ Salt	GA	0	55	TR IORE	3.18
	GA	7	6.3		
	GA	14	7.7		
	GA	28	1.1		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	GA	56	0.21		
	MO	0	22		
	MO	7	10		
	MO	14	5.8		
	MO	28	5.9		
	MO	56	1.4		
	OK 1	0	32	TR IORE	1.84
	OK 1	7	2.6		
	OK 1	14	2.8		
	OK 1	28	1.3		
	OK 1	56	0.34		
	OR	0	20	SFO	3.77
	OR	7	1.6		
	OR	14	8		
	OR	28	2.2		
	OR	56	0.59		
	WI	0	45	TR IORE	2.53
	WI	7	5.5		
	WI	14	2.4		
	WI	28	1.2		
	WI	56	0.45		
Na+ Salt	GA	0	57	SFO	6.9
	GA	7	41		
	GA	14	4.3		
	GA	28	1.4		
	GA	56	1		
	MO	0	25	TR IORE	11
	MO	7	9.3		
	MO	14	6.6		
	MO	28	3.4		
	MO	56	0.92		
	OK 1	0	23	TR IORE	7.23
	OK 1	7	9.2		
	OK 1	14	4.1		
	OK 1	28	2.4		
	OK 1	56	0.33		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OR	0	29	TR IORE	2.84
	OR	7	3.5		
	OR	14	5.5		
	OR	28	2.8		
	OR	56	3.3		
	WI	0	42	TR IORE	2.67
	WI	7	5.2		
	WI	14	3.1		
	WI	28	0.68		
	WI	56	0.38		
DMA+ Salt	FL	0	76	SFO	12.3
	FL	7	36		
	FL	14	38		
	FL	28	19		
	FL	56	1.6		
	GA	0	87	TR IORE	4.08
	GA	7	18		
	GA	14	8.1		
	GA	28	4.3		
	GA	56	0.4		
	IN	0	102		
	IN	7	306		
	IN	14	48		
	IN	28	16		
	IN	56	2.6		
	KS	0	49	TR IORE	12.1
	KS	7	28		
	KS	14	18		
	KS	28	8.6		
	KS	56	2.4		
	MI	0	44	TR IORE	4.75
	MI	7	11		
	MI	14	3.7		
	MI	28	3.1		
	MI	56	1.2		
	MO	0	42	TR IORE	6.93

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).

Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	MO	7	5.7		
	MO	14	5.8		
	MO	28	4.5		
	MO	56	2.2		
	NE	0	54	TR IORE	3.84
	NE	7	12		
	NE	14	4.5		
	NE	28	1.4		
	NE	56	0.74		
	OK 1	0	47	SFO	5.02
	OK 1	7	20		
	OK 1	14	4		
	OK 1	28	1.7		
	OK 1	56	0.36		
	OK 2	0	101	TR IORE	5.77
	OK 2	7	30		
	OK 2	14	15		
	OK 2	28	6.8		
	OK 2	56	0.88		
	OR	0	11	SFO	35.2
	OR	7	5.6		
	OR	14	3.2		
	OR	28	7.7		
	OR	56	2.9		
	TN	0	5		
	TN	7	5.9		
	TN	14	3.5		
	TN	28	3.2		
	TN	56	0.96		
	TX	0	77	TR IORE	6.67
	TX	7	21		
	TX	14	11		
	TX	28	6.9		
	TX	56	2.9		
	WI	0	571	TR IORE	1.11
	WI	7	21		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
DGA+ Salt	WI	14	4.2		
	WI	28	4.1		
	WI	56	0.82		
	FL	0	65	TR IORE	4.38
	FL	7	14		
	FL	14	8.5		
	FL	28	1.8		
	FL	56	0.069		
	MI	0	29	TR IORE	17.3
	MI	7	9.7		
	MI	14	9.8		
	MI	28	3.3		
	MI	56	2.7		
	NE	0	36	TR IORE	5.92
	NE	7	14		
	NE	14	6		
	NE	28	2.1		
	NE	56	0.078		
	OK 2	0	9.1	SFO	28.9
	OK 2	7	5.3		
	OK 2	14	4.1		
	OK 2	28	5.3		
	OK 2	56	2.2		
	TX	0	99	SFO	2.83
	TX	7	18		
	TX	14	2.5		
	TX	28	4.6		
	TX	56	0.81		
Na+ Salt	FL	0	60	TR IORE	4.81
	FL	7	18		
	FL	14	7.1		
	FL	28	2.5		
	FL	56	0.26		
	MO	0	51	TR IORE	8.43
	MO	7	7.1		
	MO	14	8.9		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	MO	28	4.3	SFO	7
	MO	56	3.4		
	OK 1	0	62		
	OK 1	7	29		
	OK 1	14	7.8		
	OK 1	28	21		
	OK 1	56	0.93		
	OR	0	14	SFO	14.9
	OR	7	7.2		
	OR	14	4.1		
	OR	28	6		
	OR	56	2.3		
	WI	0	110	SFO	2.89
	WI	7	21		
	WI	14	1.2		
	WI	28	1.4		
	WI	56	0.4		
1.0 lb/A application					
Dicamba acid	FL	0	120	TR IORE	10.3
	FL	7	33		
	FL	14	26		
	FL	28	19		
	FL	56	0.72		
	GA	0	88	TR IORE	4.18
	GA	7	21		
	GA	14	8.6		
	GA	28	3		
	GA	56	0.46		
	IN	0	116	TR IORE	9.81
	IN	7	41		
	IN	14	27		
	IN	28	17		
	IN	56	1.4		
	KS	0	116	TR IORE	9.37
	KS	7	30		
	KS	14	24		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	KS	28	14	SFO	4.74
	KS	56	3.4		
	MI	0	75		
	MI	7	29		
	MI	14	6.5		
	MI	28	3.3		
	MI	56	1.6		
	MO	0	53	TR IORE	14.8
	MO	7	25		
	MO	14	14		
	MO	28	11		
	MO	56	3.6		
	NE	0	34	SFO	5.36
	NE	7	15		
	NE	14	3.9		
	NE	28	1.6		
	NE	56	0.8		
	OK 1	0	81	TR IORE	2.74
	OK 1	7	10		
	OK 1	14	6.8		
	OK 1	28	1.2		
	OK 1	56	0.88		
	OK 2	0	119	TR IORE	5.25
	OK 2	7	30		
	OK 2	14	17		
	OK 2	28	6.3		
	OK 2	56	1.1		
	OR	0	43	SFO	3.37
	OR	7	5.1		
	OR	14	12		
	OR	28	7.4		
	OR	56	3		
	TN	0	78	TR IORE	1.87
	TN	7	7.4		
	TN	14	2.4		
	TN	28	2.5		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	TN	56	1.6	SFO	4.06
	TX	0	84		
	TX	7	25		
	TX	14	8		
	TX	28	2.6		
	TX	56	3.1		
	WI	0	64	TR IORE	5.15
	WI	7	16		
	WI	14	9.5		
	WI	28	2.5		
	WI	56	0.9		
2.0 lb/A application					
DMA+ Salt	FL	0	206	SFO	11.5
	FL	7	163		
	FL	14	81		
	FL	28	35		
	FL	56	1.6		
	FL	0	487	TR IORE	9.75
	FL	7	155		
	FL	14	138		
	FL	28	53		
	FL	56	4.6		
	GA	0	251	TR IORE	4.49
	GA	7	52		
	GA	14	36		
	GA	28	6.6		
	GA	56	0.51		
	GA	0	310	TR IORE	4.28
	GA	7	63		
	GA	14	39		
	GA	28	10		
	GA	56	0.58		
	IN	0	240	SFO	10.2
	IN	7	131		
	IN	14	83		
	IN	28	57		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).

Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	IN	56	5		
	IN	0	477	SFO	7.17
	IN	7	67		
	IN	14	220		
	IN	28	110		
	IN	56	6.1		
	KS	0	273	TR IORE	4.82
	KS	7	50		
	KS	14	35		
	KS	28	18		
	KS	56	4.6		
	KS	0	245	TR IORE	8.84
	KS	7	72		
	KS	14	49		
	KS	28	28		
	KS	56	8.1		
	MI	0	96	SFO	8.56
	MI	7	85		
	MI	14	15		
	MI	28	3.8		
	MI	56	1.8		
	MI	0	202	SFO	3.53
	MI	7	54		
	MI	14	6.3		
	MI	28	8.2		
	MI	56	2.1		
	MO	0	82	SFO	16.4
	MO	7	57		
	MO	14	34		
	MO	28	33		
	MO	56	8		
	MO	0	136	SFO	9.85
	MO	7	63		
	MO	14	47		
	MO	28	33		
	MO	56	14		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	NE	0	115	SFO	3.91
	NE	7	35		
	NE	14	6.4		
	NE	28	2.8		
	NE	56	2.1		
	NE	0	227	TR IORE	2.49
	NE	7	26		
	NE	14	15		
	NE	28	6.5		
	NE	56	2.2		
	OK 1	0	131	TR IORE	3.64
	OK 1	7	18		
	OK 1	14	18		
	OK 1	28	2.5		
	OK 1	56	2.3		
	OK 1	0	174	TR IORE	5.75
	OK 1	7	64		
	OK 1	14	28		
	OK 1	28	7		
	OK 1	56	5.5		
	OK 2	0	138	SFO	8.69
	OK 2	7	53		
	OK 2	14	64		
	OK 2	28	12		
	OK 2	56	2.6		
	OK 2	0	412	TR IORE	4.98
	OK 2	7	77		
	OK 2	14	57		
	OK 2	28	26		
	OK 2	56	6.3		
	OR	0	71	SFO	5.52
	OR	7	16		
	OR	14	23		
	OR	28	12		
	OR	56	4.9		
	OR	0	33		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OR	7	28		
	OR	14	32		
	OR	28	44		
	OR	56	19		
	TN	0	99	TR IORE	1.22
	TN	7	7.9		
	TN	14	4.1		
	TN	28	5.5		
	TN	56	2		
	TN	0	82	TR IORE	4.09
	TN	7	12		
	TN	14	8.8		
	TN	28	5.5		
	TN	56	2.4		
	TX	0	64	SFO	12.3
	TX	7	78		
	TX	14	19		
	TX	28	6.3		
	TX	56	9		
	TX	0	346	SFO	4.64
	TX	7	120		
	TX	14	39		
	TX	28	28		
	TX	56	5.5		
	WI	0	98	SFO	4.59
	WI	7	35		
	WI	14	10		
	WI	28	3.8		
	WI	56	2.6		
	WI	0	116	SFO	10.5
	WI	7	138		
	WI	14	14		
	WI	28	16		
	WI	56	4		
DGA+ Salt	GA	0	244	TR IORE	3.55
	GA	7	45		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).

Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	GA	14	22		
	GA	28	5.2		
	GA	56	0.42		
	GA	0	509	TR IORE	2.64
	GA	7	61		
	GA	14	39		
	GA	28	12		
	GA	56	1		
	MO	0	75	SFO	19.3
	MO	7	79		
	MO	14	52		
	MO	28	23		
	MO	56	10		
	MO	0	132	TR IORE	23.3
	MO	7	38		
	MO	14	48		
	MO	28	23		
	MO	56	6.8		
	OK 1	0	123	SFO	3.03
	OK 1	7	24		
	OK 1	14	6.2		
	OK 1	28	8.6		
	OK 1	56	2.4		
	OK 1	0	231	SFO	6.19
	OK 1	7	126		
	OK 1	14	30		
	OK 1	28	7.5		
	OK 1	56	0.92		
	OR	0	69	SFO	4.23
	OR	7	8		
	OR	14	24		
	OR	28	18		
	OR	56	2.6		
	OR	0	49		
	OR	7	29		
	OR	14	27		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).					
Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OR	28	37	TR IORE	5.24
	OR	56	12		
	WI	0	98		
	WI	7	27		
	WI	14	13		
	WI	28	5.1		
	WI	56	1.6		
	WI	0	287	SFO	3.17
	WI	7	64		
	WI	14	8		
	WI	28	15		
	WI	56	2.7		
Na+ Salt	GA	0	358		
	GA	7	8.2		
	GA	14	47		
	GA	28	6.4		
	GA	56	0.17		
	GA	0	559	TR IORE	2.39
	GA	7	62		
	GA	14	36		
	GA	28	9.3		
	GA	56	0.1		
	MO	0	92	SFO	11.2
	MO	7	54		
	MO	14	28		
	MO	28	28		
	MO	56	7.3		
	MO	0	134	SFO	7.61
	MO	7	39		
	MO	14	56		
	MO	28	17		
	MO	56	15		
	OK 1	0	131	TR IORE	9.49
	OK 1	7	28		
	OK 1	14	28		
	OK 1	28	14		

Table A4-1. Foliar half-life values calculated from residue data as presented in the HED review of Jimenez 1994 (MRID 43370701; DP Barcode 207649).

Dicamba Salt	Sample Location	Post Treatment Measurement Interval (d)	Residue Value	Best Fit Equation (based on Degradation Kinetics Guidance ¹)	Foliar Half-Life (d)
	OK 1	56	4.7	SFO	4.75
	OK 1	0	206		
	OK 1	7	71		
	OK 1	14	31		
	OK 1	28	3		
	OK 1	56	3.9		
	OR	0	94	TR IORE	8.24
	OR	7	9.4		
	OR	14	16		
	OR	28	15		
	OR	56	1		
	OR	0	44	SFO	43.7
	OR	7	38		
	OR	14	11		
	OR	28	50		
	OR	56	7.7		
	WI	0	99	TR IORE	4.41
	WI	7	19		
	WI	14	13		
	WI	28	3.9		
	WI	56	0.72		
	WI	0	342	TR IORE	2.83
	WI	7	45		
	WI	14	23		
	WI	28	14		
	WI	56	1.4		
				Mean	7.272828
				Standard Deviation	6.580145
				n	99
				Maximum	43.7
				Minimum	1.11
				Upper 90% CI on the mean	8.360618

¹ 2012 Memorandum from the Fate Tech Team: Release of NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media.

Appendix 5. Lesser Prairie-Chicken habitat characteristics identified by Jamison et al. (2002).

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
1	New Mexico	Cropland, idle, shinnery oak (<i>Quercus havardii</i>) pasture, shortgrass pasture, tame pasture	Hens with broods preferred shinnery oak pasture over cropland, fallow cropland, shortgrass, and tame pastures; broods used sites characterized by 25% canopy cover of vegetation, canopy height of about 30 cm, 24-39% basal composition of shrubs, 47-60% grasses, and 13-26% basal composition of forbs; adults used grain sorghum fields during autumn and winter
2	Kansas	Cropland, sand sagebrush (<i>Artemisia filifolia</i>) pasture	Nested in sand sagebrush pasture and foraged in cropland during winter
3	Oklahoma	Burned shinnery oak pasture, burned tame pasture, shinnery oak pasture	Continued to display at a lek in burned pasture; males relocated from an unburned lek to a historical site in a burned weeping lovegrass (<i>Eragrostis curvula</i>) pasture and initiated display at a new site in burned shinnery oak/bluestem (<i>Andropogon</i>) pasture
4	Oklahoma	Sand sagebrush pasture, shinnery oak pasture	Densities of birds in shinnery oak pasture were positively correlated with grass cover and grass frequency along transects, and with percent of grassland cover types identified from satellite imagery; in sand sagebrush pasture, numbers of birds were positively correlated with percent cover of shrubs and grass frequency along transects, but were not associated with percentages of cover types identified from satellite imagery
5	Oklahoma	Cropland, mixed-grass pasture, sand sagebrush pasture, shinnery oak pasture	Nested in residual grasses and shinnery oak; raised broods in shinnery oak thickets; foraged in cropland (food plots) during winter
6	Texas	Honey mesquite (<i>Prosopis glandulosa</i>)/shortgrass pasture, shinnery oak pasture	Preferred pastures dominated by shinnery oak and sand bluestem (<i>Andropogon hallii</i>); avoided honey mesquite/shortgrass areas; nested more successfully in residual sand bluestem than in other vegetation types; selected nest sites with north or northeast aspects, more litter and less bare ground than elsewhere in the habitat, and taller vegetation than the average vegetation height within 3 m; broods preferred shinnery oak/sand bluestem pasture and avoided mesquite/shortgrass habitat; broods foraged at sites with a minimum vegetation height of 24 cm and lower grass

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
			abundance and greater shrub abundance than generally was available
7	Oklahoma	Cropland, native pasture	Displayed on sparsely vegetated, flat-topped ridges overlooking expansive areas of native pasture and on slightly raised knolls that provided unobstructed views of broad valleys
8	Oklahoma	Sand sagebrush pasture, shinnery oak pasture	More individuals were encountered in phenoxy herbicide-treated shinnery oak and phenoxy herbicide-treated sand sagebrush pastures than in untreated habitats of the same types
9	Colorado	Sand sagebrush pasture	Nested among taller grasses (36 vs. 27 cm), forbs (21 vs. 16 cm), and shrubs (48 vs. 38 cm), and denser vegetation (32 vs. 20 cm) compared to areas within 5 m; nested mostly under sand sagebrush and yucca (<i>Yucca glauca</i>); at 29 nest sites, tallest vegetation averaged 51 cm, sand sagebrush plant density was 3471 plants/ha, sand sagebrush cover was 7.2%, grass cover was 29.4%, forb cover was 1.4%, and bare ground was 69.5%
10	Texas	Shinnery oak/sand sagebrush pasture	Selected untreated shinnery oak pastures for nesting over tebuthiuron-treated pastures of the same type; eight of 10 females that were captured in tebuthiuron-treated areas later nested in untreated shinnery oak; 13 nests were in residual grasses with 42% overhead cover, average plant height of 45 cm, and average visual obstruction of 61-80% in the first 33 cm above ground; vegetation was dominated by purple three-awn (<i>Aristida purpurea</i>) at nine nest sites, little bluestem (<i>Schizachyrium scoparium</i>) at three nests, and sand bluestem at one nest
11	Colorado	Cropland, mixed-grass pasture, sand sagebrush pasture	Males displayed at lek sites on slightly elevated terrain or on level flats; foraged in cropland during winter
12	Texas	Cropland, sand sagebrush pasture, shinnery oak pasture	Used pastures vegetated by sand sagebrush, chickasaw plum (<i>Prunus angustifolia</i>), fragrant sumac (<i>Rhus aromatica</i> var. <i>trilobata</i>), shinnery oak, sand bluestem, little bluestem, sand lovegrass (<i>Eragrostis trichodes</i>), sand dropseed (<i>Sporobolus cryptandrus</i>), thin paspalum (<i>Paspalum setaceum</i>), switchgrass (<i>Panicum virgatum</i>), Indiangrass (<i>Sorghastrum nutans</i>), and various forbs; foraged in cropland during winter

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
13	Kansas	Cropland, sand sagebrush pasture	Males preferred habitats vegetated by sand sagebrush, blue grama (<i>Bouteloua gracilis</i>), sideoats grama (<i>Bouteloua curtipendula</i>), paspalum (<i>Paspalum</i> sp.), bluestem, western ragweed (<i>Ambrosia psilostachya</i>), sunflowers (<i>Helianthus</i> spp.), Russian-thistle (<i>Salsola iberica</i>), prickly pear (<i>Opuntia</i> sp.), and yucca and used cultivated fields, tallgrass and CRP, and other grassland habitats less than expected; median sizes of areas used by males were 12-140 ha in April and May, 77-144 ha from June through September, and 229-409 ha in October and November
14	Oklahoma	Sand sagebrush/mixed-grass pasture	Displayed in areas dominated by buffalograss; raised broods in areas with 22.8% sand sagebrush and 15.7% western ragweed; foraged in mixed-grass, rested among shrubs, and nested in residual grasses; broods also used shrubs; on a year-round basis, foraged mostly in grass, especially mixed-grass 25-80 cm in height; tallgrass, shortgrass, and shrub vegetation were used equally; sixweeks fescue (<i>Festuca octoflora</i>) and fragrant sumac were important food items; during spring, used shrubs <80 cm tall; used grasses and forbs 25-80 cm in height during summer, and grasses 25-80 cm tall during autumn; in winter, used tallgrass (specific heights of tallgrass species were not given)
15	New Mexico	Cropland, shinnery oak/sand sagebrush pasture	Used pastures vegetated by shinnery oak, bluestem grasses, sand sagebrush, sunflower, honey mesquite, plum, yucca, dropseed, black grama (<i>Bouteloua eriopoda</i>), blue grama, and sideoats grama; foraged in grain sorghum and corn fields from fall through spring
16	New Mexico, Oklahoma, Texas	Cropland, shinnery oak pasture, shinnery oak/little bluestem pasture	Annual rates of habitat change were greater around leks with declining populations than at leks with stable populations (1.14% vs. 0.21% annually)
17	New Mexico	Shinnery oak pasture, shortgrass pasture	Displayed on oil pads and in native pasture
18	New Mexico	Cropland, oldfield, shinnery oak pasture, shortgrass pasture, tame pasture	Nested in shinnery oak habitats with little bluestem, sand bluestem, and purple three-awn; avoided weeping lovegrass, cultivated, oldfield, and shortgrass habitats

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
19	New Mexico, Texas	Shinnery oak/sand sagebrush pasture	Occurred in similar densities in tebuthiuron-treated and untreated shinnery oak pastures
20	New Mexico	Shinnery oak pasture, shortgrass pasture	Nested in shinnery oak habitats dominated by sand bluestem; vegetation was taller at 10 successful than 26 unsuccessful nests (67 vs. 35 cm); percent composition of shrubs was similar at successful and unsuccessful nests (basal composition 31-66%); 22 autumn foraging sites were 63% grasses and 37% shrubs, 50 winter sites were 59% grasses and 41% shrubs (forbs were rare); broods foraged in 25-cm tall shinnery oak and three-awn (<i>Aristida</i> sp.), bare ground at 12 sites averaged 63%, basal composition of vegetation was 43% grass, 42% shrubs, and 15% forbs; daily movements of 40 prenesting females were 390 m/day within 231-ha ranges; 12 nesting hens moved 250 m/day, and ranges averaged 92 ha; three hens with broods moved an average of 280 m/day within 119-ha ranges; movements of 19 females without broods was 220 m/day within 73-ha ranges
22	New Mexico	Shinnery oak/sand sagebrush pasture	Hens generally used habitats with large unstable sand dunes, abundant shinnery oak, low grass cover, and low structural density; nested in sand sagebrush, residual grasses, and shinnery oak; five of eight nests were under sand sagebrush, two nests were in purple three-awn, and one nest was in shinnery oak; visual obstruction and canopy cover of sand sagebrush were significantly higher at nest sites than in surrounding habitat (specific values for visual obstruction, canopy cover, and canopy height were not given)
23	Texas	Cropland, oldfield, shinnery oak pasture, shortgrass pasture, tame pasture	Prenesting and nesting hens preferred shinnery oak habitat characterized by rolling dunes and dominated primarily by shinnery oak, habitat dominated by little bluestem and sand bluestem, or habitat dominated by three-awn and shinnery oak; canopy coverage of grasses within 3 m of nest sites was 3.1-13.2%, shrub canopy was 21.4-28.3%, and canopy coverage of all vegetation was 31.4-38.4%; nests in grasses were more successful (4 of 5 successful) than those under shrubs (3 of 10 successful)
24	New Mexico	Cropland, oldfield, shinnery oak pasture, shortgrass pasture, tame pasture	Prenesting and nesting hens preferred shinnery oak habitat characterized by rolling dunes and dominated primarily by shinnery oak, habitat dominated by little bluestem and sand bluestem, or

Study	Location(s)	Habitat(s) Studied	Species-Specific Habitat Characteristics
			habitat dominated by three-awn and shinnery oak; canopy coverage of grasses within 3 m of nest sites was 3.1-13.2%, shrub canopy was 21.4-28.3%, and canopy coverage of all vegetation was 31.4-38.4%; nests in grasses were more successful (4 of 5 successful) than those under shrubs (3 of 10 successful)
25	New Mexico, Oklahoma, Texas	Cropland, shinnery oak pasture, shinnery oak/little bluestem pasture	Populations stabilized or increased in landscapes (7238-ha areas) in which low-density shrubland composed 79.% of the total area and declined in landscapes with 43.2% low-density shrubland; total shrubland composed 81.9% around leks that did not decline and 63.4% of the landscape around declining leks; declined in areas where landscapes were unstable (e.g., experienced frequent changes from one landcover to another); population trends were positively correlated with loss of total shrubland



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

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Date: March 24, 2016

MEMORANDUM

Subject: Addendum to Dicamba Diglycolamine (DGA) Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States (Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas)

To: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
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Office of Pesticide Programs

From: Elizabeth Donovan, Biologist
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Office of Pesticide Programs

Through: Mark Corbin, Branch Chief
Environmental Risk Branch 6
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Office of Pesticide Programs

Prior to conducting this refined Endangered Species Assessment, the Environmental Fate and Effects Division (EFED) performed a screening level ecological risk assessment for a Federal

action involving proposed new uses of the diglycolamine salt of dicamba (dicamba DGA) on dicamba herbicide-tolerant soybean on March 8, 2011 (DP 378444); an amendment to the assessment was issued on May 20, 2014 (DP 404138, 404806, 405887, 410802, and 411382). Concurrent with this refined Endangered Species Assessment, a Section 3 New Use dicamba DGA salt on dicamba-tolerant cotton screening-level assessment (DP 404823) and a subsequent addendum (DP 426789) that addresses multiple issues (spray drift buffers, runoff, risk to terrestrial invertebrates and updated mammalian toxicological endpoints for parent dicamba and its degradate, DCSA) have been finalized. In the screening level risk assessment, potential direct risk concerns could not be excluded for:

- mammals (chronic, from the soybean use only, due to residues from dicamba's metabolite, DCSA, rather than from parent dicamba);
- birds (acute from parent dicamba for both soybean and cotton uses; chronic from DCSA residues only in soybean but not in cotton), considered surrogates for reptiles, and terrestrial-phase amphibians; and
- terrestrial plants (soybean and cotton uses)

In the screening level risk assessments, indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Additionally, the screening level assessments showed that direct risk concerns were unlikely (*i.e.* levels of concern were not exceeded) for:

- mammals (acute) and (chronic—for the cotton use only);
- birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton);
- terrestrial insects (acute and chronic);
- freshwater fish (acute and chronic);
- aquatic-phase amphibians (acute and chronic);
- estuarine/marine fish (acute and chronic);
- freshwater invertebrates (acute and chronic); estuarine/marine invertebrates (acute and chronic); and
- aquatic plants¹

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk

¹ The listed species LOC was exceeded for non-vascular aquatic plants, however there are no listed species of this taxa.

Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations. At each screening step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still exceeds the Agency’s levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. When a given taxonomic RQ exceeds either the acute or chronic LOC a concern for direct toxic effects is identified for that particular taxon. If RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

The purpose of this document is to explain the refined risk assessment conducted for Federally-listed threatened or endangered (listed) species that could potentially be impacted by this pesticide registration. The refined assessment was conducted based on the 2004 Overview document, as discussed above. The assessment of risks to listed species posed by the use of Dicamba DGA has been conducted in phases covering a specific set of states, assessing risk to all the listed species covered in those states. This assessment covers the endangered species analysis for 7 states: Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina and Texas. Based on EFED’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), 307 species in the 7 states proposed for registration were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant soybean and cotton uses. **Table 1** presents a summary of this assessment. Separate concurrent assessment phases cover the endangered species analysis for 16 states (D416416, 420160, 420159, 420352, 421434, 421723 covering AR, IL, IA, IN, KS, LA,

MN, MS, MO, NE, ND, OH, OK, SD, TN and WI) and 11 states (D425049 covering AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV).

EPA consulted U.S. Fish and Wildlife Service Recovery Plans to determine whether listed species in these states would be expected to occur in an action area encompassing the treated soybean and corn fields. The refined assessment was then conducted on those species that could not be excluded from the action area. EPA also consulted the recovery plans in the refined assessment for additional habitat information and incorporated species biological information regarding dietary items (used to model dicamba DGA residues in prey tissue) and body weight (used to determine food consumption rates and scale ecotoxicity data from the tested surrogate species, the bobwhite quail and rat, to the body weight of the listed species).

The Environmental Fate and Effects Division (EFED) has completed an endangered species risk assessment for Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas in support of registering dicamba diglycolamine (DGA) salt on herbicide-tolerant cotton and soybean in these states. **Table 1** presents a summary of the assessment.

Table 1. Summary of species effects determinations and critical habitat modification determinations for Federally threatened or endangered species in Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas for dicamba DGA use on genetically modified cotton and soybeans.

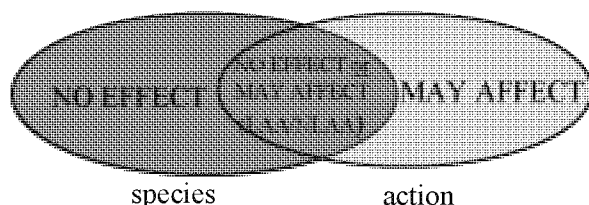
Species	Effects Determination	Comments
Eskimo Curlew	May Affect, Not Likely to Adversely Affect	Found in 24 counties (23 in Nebraska and 1 in Texas)
All other species (terrestrial and aquatic)	No effect	None
Critical Habitat	Modification Determination	Comments
All Critical Habitats (118 species)	No Modification	None

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have **NO EFFECT**.
- For listed individuals outside the action area, use of a pesticide would be determined to have **NO EFFECT**.

- Listed individuals inside the action area may either fall into the NO EFFECT or MAY AFFECT (LIKELY or NOT LIKELY TO ADVERSELY AFFECT) categories depending upon their specific biological needs, circumstances of exposure, etc.



- LIKELY or NOT LIKELY TO ADVERSELY AFFECT determinations are made using the following criteria:
 - Insignificant - The level of the effect cannot be meaningfully related to a “take.”
 - Highly Uncertain - The effect is highly unlikely to occur.
 - Wholly beneficial - The effects are only good things.

Spray Drift Mitigation

EFED’s refined endangered species risk assessment took into account the spray drift mitigation language that has been added to the most recent proposed label submitted by the registrant. An accounting of federally-listed threatened or endangered species within the 7 states (covered in this assessment) proposed for dicamba DGA use on genetically modified cotton and soybeans is included in **Appendix 1** (307 species). Specifically, the spray drift mitigation language on the M1691 Herbicide Supplemental labels for the use dicamba DGA salt on ROUNDUP READY 2 XTEND™ soybean and BOLLGARD II® XTENDFLEX cotton includes the following limitations:

- Specifying the use of a nozzle (Tee Jet® TT11004) with ASABE S-572 ultra-coarse and extremely coarse droplet spectra and a maximum operating pressure of 63 psi.
- A maximum equipment ground speed of 15 miles per hour and ground boom height of 24 inches above the target pest or crop canopy.
- Restricting all applications when wind speeds are < 3 mph or > 15 mph and restricting applications when wind is blowing towards sensitive areas at > 10 mph. Maintaining use of a 110 foot in-field buffer for a 0.5 lb a.i./A application (220 foot in-field buffer for a 1 lb a.i./A application) when the wind is blowing towards any areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures.
- Applications done in low relative humidity conditions are to use equipment set to produce larger droplet spectra to compensate for evaporation.
- Applications are not be conducted during temperature inversions.

- In order to prevent effects to non-target susceptible plants, the label also includes the following language: “do not apply under circumstances where spray drift may occur to food, forage or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants because severe injury or destruction may result, including plants in a greenhouse. Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from the off-target movement of M1691 Herbicide. The Applicator must survey the application site for neighboring sensitive areas prior to application. The applicator also should consult sensitive crop registries for locating sensitive areas where available.”
- Finally, in order to prevent unintended damage from the drift of M1691 Herbicide, the label says not to apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

The incorporation of the spray drift mitigation measures into the product labeling as outlined above would result in exposure to dicamba DGA from spray drift at a level where effects are expected only within the confines of the treated field and so the action area is limited to the dicamba DGA treated field. Further, the incorporation of the “susceptible plants” spray drift mitigation language on the label is to avoid damage to these plants (including adjacent crops). Because the risk assessment interprets the threshold for plant damage concern to be based on the most sensitive plant species tested and the screening level ecological risk assessment has demonstrated that these plant effects endpoints constitute the most conservative terrestrial organism levels of effect, it is concluded that the “susceptible plants” requirement requires a level of drift mitigation that would also prevent less sensitive organisms from being exposed at levels of concern. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to dicamba DGA, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any effects thresholds of concern. Additionally, as indicated in the screening level ecological risk assessments for cotton and soybean, no aquatic receptor taxa are of concern for drift or runoff exposure (LOCs were not exceeded for aquatic taxa). **Consequently, all but 14 of the listed species originally identified as potentially at-risk are determined to be given a “no effect” (NE) without further refinement because they are not expected to occur in an action area encompassing the treated soybean and cotton fields (Appendix 2).** The remaining 16 species are assessed using the refinements set forth in the 2004 Overview document referred to earlier in this assessment.

Exposure through Runoff

The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted

concentrations from modeling were lower than the most sensitive taxa's endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a "no effects" determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would also protect against the risk of exposure to listed species off the treated field.

In addition to the spray drift and runoff mitigation measures contained in the proposed labeling, EFED analyzed species-specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment. An accounting of the federally-listed threatened or endangered species within the 7 states proposed for this registration showed 307 listed species as potentially at risk (direct or indirect effects) as a result of the screening-level assessment (**Appendix 1**). The spray drift mitigation label language cannot preclude listed species being exposed to dicamba DGA salt or DCSA residues on treated fields, should a listed species utilize such areas as part of its range and corresponding habitat. Of the 307 listed species within the 7 states (AL, GA, KY, MI, NC, SC, and TX) considered part of the proposed Federal decision, the following 14 species were reasonably expected to occur on soybean and cotton fields, which could potentially be treated with dicamba and therefore could not be assumed to be "no effect" solely on the basis of occurrence outside the action area:

Of these 14 species, a "no effect" determination was reached in the concurrent assessment action for 16 states (DP 416416, 420160, 420159, 420352, 421434, 421723 covering AR, IL, IA, IN, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI) for the following species and is applicable to the additional seven states in this refined assessment as well:

- American burying beetle (*Nicrophorus americanus*)
- Gopher tortoise (*Gopherus polyphemus*)
- Indiana bat (*Myotis sodalis*)
- Lesser prairie-chicken (*Tympanuchus pallidicinctus*)
- Louisiana black bear (*Ursus americanus luteolus*)
- Whooping crane (*Grus americana*)

This leaves the following species for which the remainder of this document uses species specific biological information and dicamba DGA use patterns in more depth to further refine the assessment and effects determinations:

- Attwater's greater prairie-chicken (*Tympanuchus cupido attwateri*)
- Eskimo curlew (*Numenius borealis*)
- Eastern indigo snake (*Drymarchon corais couperi*)
- Houston toad (*Bufo houstonensis*)

- Virginia big-eared bat (*Corynorhinus (=Plecotus) townsendii virginianus*)
- Ocelot (*Leopardus (Felis) pardalis*)
- Gulf Coast jaguarundi (*Herpailurus (=Felis) yagouaroundi cacomitli*)
- Red wolf (*Canis rufus*)

Therefore, species specific biological information (e.g., body size, dietary requirements, and seasonality) and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations.

This assessment also uses the refined exposure values determined in the cotton screening level assessment and the concurrently issued addendum to the soybean screening level risk assessment documents compared to the initial exposure estimates from the soybean screening level assessment. This ESA assessment also evaluates chronic exposures from DCSA separately from the chronic exposure to parent dicamba. Dicamba exposure values were determined from the upper bound of the modeled T-REX run for exposures following spray applications based on the Kenaga nomogram modified by Fletcher *et al* (1984), which is based on a large set of actual field residue data. Modeled dicamba exposure values were identical between the soybean addendum and the cotton screening level risk assessment (since the maximum application rates and minimum application intervals are the same).

Similar modeling of DCSA residues, which are formed inside the tolerant-soybean and tolerant-cotton plants through plant metabolism, is not feasible at this time due to a lack of sufficient data tracking DCSA residues in plant tissues over time to ascertain degradation rates. Therefore, in the soybean addendum and the cotton screening-level risk assessment, EFED used the maximum empirical measured DCSA residue concentrations in dicamba-tolerant soybean (61.1 mg/kg (ppm) DCSA in broadleaf plants and 0.440 ppm in soybean seeds) and cotton plant tissues (6.29 ppm DCSA in cotton gin byproducts and 0.27 ppm in undelinted cotton seed) to evaluate chronic exposures to DCSA for animals foraging on soybean and cotton plants. Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed soybean/cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications (*i.e.* arthropod concentrations estimated to be approximately 70% of the concentrations in broadleaf plant tissues or 42.5 ppm DCSA in arthropods feeding on soybean plants and 4.4 ppm in arthropods feeding on cotton plants). The empirical residue data for cotton indicated that chronic exposures of birds and mammals to dicamba or DCSA in cotton tissues **would not** be above any levels of concern. Although the concurrently issued soybean addendum indicates that chronic risk to mammals and birds was only a concern from DCSA residues in plant/prey tissues and not from residues of parent dicamba, since the original soybean screening-level assessment (USEPA, 2011) indicated chronic risk to mammals, this assessment presents the estimated exposures and comparisons to threshold toxicity values for both dicamba and DCSA for mammals, but evaluates them separately since their chronic toxicity and exposure profiles differ greatly. For birds, following

the conclusions of the screening level assessments and the soybean addendum, only acute risk from dicamba exposures and chronic risk from DCSA exposures is evaluated.

The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Refined ecological risk assessment for the remaining species potentially exposed to dicamba residues

For the effects determinations for Attwater's prairie-chicken, eskimo curlew, Eastern indigo snake, Houston toad, Virginia big-eared bat, ocelot, Gulf Coast jaguarundi and red wolf, a refined risk assessment approach was used to evaluate additional lines of evidence to determine whether the conservative generic assumptions in the screening risk assessment apply to a particular species of interest (*e.g.* the Attwater's prairie-chicken). In the case of the prairie-chicken, the refined risk assessment investigated the impacts of more chicken specific data related to:

1. Bird size (as the chicken is smaller than the 1000g large bird category used in the initial screen)
2. Bird food consumption tailored to:
 - a. The true weight of the bird
 - b. Energy requirements of the chicken
 - c. Improvement on the generic food intake model of the screen to assess energy content of the diet and the actual free living energy requirements of a bird the size of a chicken
3. Toxicity endpoints were scaled from the weight of the tested surrogate species (bobwhite quail) to reflect the comparatively larger actual size of the Attwater's greater prairie chicken

Using the Attwater's greater prairie chicken as an example to show how EPA made its effects determinations, EPA determined that the chicken could be feeding on arthropod prey in treated cotton and soybean fields. As stated above, for acute and chronic exposures to dicamba, EPA used the upper bound predicted concentrations of dicamba DGA salt found on arthropods from T-REX modeling. For chronic exposures to DCSA residues, EPA used the maximum measured concentrations found in broadleaf plants, modified by the Kenaga relationship between broadleaf plants and arthropods. EPA used the predicted concentrations of dicamba DGA salt found on arthropods as its conservative prey analysis consistent with the preliminary risk concerns identified in the screening assessment. This prey analysis is consistent with the preliminary risk concerns identified in the screening assessments. This analysis is conservative as it assumes 1) that 100% of the chicken's food consumption comes from exposed arthropods and 2) the level of

dicamba DGA residues assumed to be on these prey arthropods is based on the upper bound Kenaga residues expected for arthropods directly exposed to spray applications of dicamba DGA and for exposure to DCSA that residues in the arthropod prey item are based on the maximum measured values in broadleaf plant tissues modified by the Kenaga relationship between residues in arthropods and broadleaf plants following spray applications. EPA determined the field metabolic rate of the prairie chicken through the use of a published peer reviewed allometric equation that relates bodyweight to energy requirements. From there the mass of prey consumed per day is determined by dividing the field metabolic rate (kcal/day) by the energy content of the arthropod prey and an assimilation factor that accounts for the ability of birds to absorb that energy from the diet. Values were obtained from a published peer reviewed EPA document produced by the Office of Research and Development for Agency-wide use in conducting ecological risk assessment (USEPA, 1993). The mass of dicamba DGA in the insect diet is determined from the T-REX run found in the addendum to the screening-level risk assessment, issued concurrently with this risk assessment (USEPA, 2016a) while the mass of DCSA in insect diet was assumed to be 42.5 ppm (70% of the maximum measured residues in soybean hay of 61.1 ppm). The mass of prey consumed per day is then multiplied by the mass of dicamba or DCSA in the insect diet to determine the mass of dicamba or DCSA in the chicken's daily diet in mg/day. Then the daily dose that the chicken (considering its bodyweight) receives is determined by multiplying the mass of dicamba or DCSA in the daily diet of arthropods (assuming that is the only food item) times the mass of prey consumed per day divided by the bodyweight of the prairie chicken. Then EPA scaled the acute toxicity endpoint (based on the tested surrogate bird species, bobwhite quail's default weight of 178 grams) to the bodyweight of the prairie chicken to determine the acute oral toxicity for the prairie chicken. For exposures to DCSA residues, the chronic toxicity endpoint for the mallard (the most sensitive tested species) was modified by the relationship between the chronic dicamba and DCSA endpoints for rats (a 17x difference). The acute RQ for dicamba exposures is then calculated by dividing the daily dose of dicamba from consuming arthropods by the acute oral toxicity endpoint while the chronic RQ is calculated by dividing the daily dose of DCSA by the chronic toxicity endpoint. In this case the acute RQ for dicamba was 0.08, which is below the endangered species level of concern of 0.1, while the chronic RQ for DCSA was 0.18, which is below the listed and non-listed species chronic LOC of 1.0. At this point, EPA was able to conclude that dicamba and its metabolite DCSA would not have an effect on the Attwater's greater prairie-chicken.

Birds

The screening-level assessments showed that birds could be at risk of mortality from acute exposures to dicamba DGA on treated fields, but chronic risk was not expected as no chronic RQs exceeded the Agency's LOC (1.0) for chronic risk (USEPA 2011. D378444, p. 15). The concurrently issued soybean addendum did indicate that chronic exposures to DCSA residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, for listed species that could reasonably be expected to occur on treated soybean and

cotton fields, EPA conducted a refined assessment for acute (dicamba only) and chronic (DCSA only, and only for soybean) exposures. Of the remaining bird species identified as potentially at acute risk in the seven states, two are reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

Attwater's greater prairie-chicken

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds indicated concerns for acute effects. The assumptions in the initial screen were adjusted to account for the prairie-chicken's biology. Attwater's prairie chickens are omnivorous, feeding on a variety of dietary items including seeds and pods, insects, broadleaf plants and grasses, with adults feeding primarily on grain, while juvenile chickens primarily consume insects. (Lehman, 1941). Therefore, at the time of post-emergent dicamba applications (late spring, summer), the most attractive dietary items in soybean and cotton fields will be waste grain from weed species and terrestrial invertebrates. As a conservative approach, EPA used the modeled upper bound T-REX residues for arthropods (which were higher than the modeled residues in grain) to evaluate the potential risk posed by dicamba applications at this time. This is considered a conservative approach as modeled residues in arthropods are higher than for the other most likely dietary items and 100% of the chicken's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. Agricultural grains are expected to have lower residues than those predicted for arthropods and other dietary items, such as broadleaf plant tissues are not expected to constitute as significant a source of the chicken's diet compared to arthropods, for juvenile chickens, or grain for adult chickens (Lehman, 1941). A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(772)^{0.749} = 166.73$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Attwater's greater prairie-chicken from US FWS Recovery Plan (USFWS, 2010);
http://ecos.fws.gov/docs/recovery_plan/100426.pdf)

Mass of prey consumed per day = $166.73 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 136.22$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USFWS, 2010, Lehman, 1941)

Mass of dicamba DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = 136.22 g/day X 102.99 mg dicamba DGA/kg-ww insect prey X 0.001 = 14.03 mg/day

Daily dose in chicken = 14.03 mg dicamba DGA/day/0.772= **18.17 mg/kg-bw/day**

Chicken LD50 mg/kg-bw = 188 mg/kg-bw X (772/178)^(1.15-1) = **234.28 mg/kg-bw**

The RQ for acute effects = 18.17/234.28 = **0.08**

An acute RQ of 0.08 does not exceed the acute LOC of 0.1. Consequently, EPA makes a “no effect” determination for the Attwater’s greater prairie chicken

DCSA Assessment for Attwater’s greater prairie chicken consuming arthropods that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the chicken’s diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. Agricultural grains are expected to have lower residues than those predicted for arthropods and other dietary items, such as broadleaf plant tissues are not expected to constitute as significant a source of the chicken’s diet compared to arthropods, for juvenile chickens, or grain for adult chickens (Lehman, 1941). A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(772)^{0.749} = 166.73$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Attwater’s greater prairie-chicken from US FWS Recovery Plan (USFWS, 2010); http://ecos.fws.gov/docs/recovery_plan/100426.pdf)

Mass of prey consumed per day = 166.73 kcal/day/(1.7 kcal/g ww X 0.72 AE) = 136.22 g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USFWS, 2010, Lehman, 1941)

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 136.22 g/day X 42.5 mg DCSA/kg-ww insect prey X 0.001
= 5.79 mg/day

Daily dose in chicken = 5.79 mg DCSA/day/0.772 = **7.50 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 7.5/40.88 = 0.18$

An RQ of 0.18 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Atwater’s greater prairie chicken.**

Eskimo curlew

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds indicated concerns for acute effects. The Eskimo curlew is a species determined to potentially occupy treated agricultural fields such as cotton and soybean fields and thus be subject to exposure to dicamba DGA on the treated field. Historically, the species’ breeding grounds were in Alaska and the Northwest Territories, Canada and overwintered in South America (USFWS, 2011a). The curlew is thought to have crossed the Gulf of Mexico into Texas during their spring migrations and preferred burned and disturbed prairie habitats and agricultural fields where they fed primarily on grasshoppers and other insects (Gill et al., 1998, USFWS, 2011a). The assumptions in the initial screen were adjusted to account for the Eskimo curlew’s biology. As a conservative approach, EPA used the modeled upper bound T-REX modeled residues for arthropods to evaluate the potential risk posed by dicamba applications at this time. This is considered a conservative approach as 100% of the Eskimo curlew’s diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(240)^{0.749} = 69.5$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Eskimo curlew from USGS, 2014 <http://www.npwrc.usgs.gov/resource/birds/curlew/identif.htm>)

Mass of prey consumed per day = $69.5 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 56.8$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USGS 2014)

Mass of dicamba DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = 56.8 g/day X 102.99 mg dicamba DGA/kg-ww insect prey X 0.001 = 5.85 mg/day

Daily dose in curlew = 5.85 mg dicamba DGA/day/0.24 = **24.37 mg/kg-bw/day**

Curlew LD50 mg/kg-bw = 188 mg/kg-bw X (240/178)^(1.15-1) = **196.6 mg/kg-bw**

The RQ for acute effects = 24.37/196.6 = **0.12**

An acute RQ of 0.12 exceeds the acute LOC of 0.1.

DCSA Assessment Eskimo curlew consuming arthropods that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as the estimated residues in arthropods are higher than for the other likely dietary items and 100% of the curlew's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $1.146(240)^{0.749}$ = 69.5 kcal/day
(USEPA 1993, body weight reflects screening assumption for the Eskimo curlew from USGS, 2014 <http://www.npwrc.usgs.gov/resource/birds/curlew/identif.htm>)

Mass of prey consumed per day = 69.5 kcal/day/(1.7 kcal/g ww X 0.72 AE) = 56.8 g/day
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, assumption of insect prey from USGS 2014)

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 56.8 g/day X 42.5 mg DCSA/kg-ww insect prey X 0.001 = 2.41 mg/day

Daily dose in chicken = 2.41 mg DCSA/day/0.240 = **10.06 mg/kg-bw/day**

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 10.06/40.88 = 0.25$

An RQ of 0.25 does not exceed the chronic LOC of 1.0

As the analysis above concluded that exposures to the curlew from dicamba had potential to be above the acute level of concern, the assessment was further refined by using of the Terrestrial Investigation Model (TIM) to quantify the potential risks of dicamba DGA to the Eskimo curlew. The model was parameterized with two assumptions about the frequency of time they would spend on the field (frequency on field: FOF): 10 percent and 90 percent. These assumptions reflect the overall uncertainty of how much time in a given migration period the birds would encounter a feeding opportunity on crop land. The model simulated a three-day stopover in agricultural land during the early pre-emergence herbicide application season to simulate feeding during migration. The food uptake was raised to a 3X daily intake rate to simulate migratory gorging behavior. The results indicated a 5.4-94% chance of mortality to one or more Eskimo curlews (**Table 4**). The dominant route of exposure that contributes to mortality is through diet (**Table 5**). The input parameters used in this model run are included in **Appendix 3**.

Table 4. Risk of dicamba exposure to individual Eskimo curlew.

Mean FOF (%)	% Chance of mortality to one or more birds
10	5.4
90	94

Table 5. Relative contributions of exposure routes to lethal doses in simulated birds. Mean (and standard deviation) values provided.

Exposure route*	10% FOF	90% FOF
Food	93 (6.6)	84 (7.5)
Drinking water: Puddles	0	0
Drinking water: Dew	0	0
Dermal Contact	6.8 (6.6)	16 (7.5)

*Inhalation and direct spray routes of exposure were turned off.

Given the predicted chance of individual mortalities, it might be reasonable to expect effects if Eskimo curlews encountered treat fields. Known occurrences of the species span Galveston County in Texas and 23 counties in Nebraska: Nuckolls, Jefferson, Saline, Polk, Wayne, Pierce, Platte, Boone, Madison, Antelope, Merrick, Stanton, Fillmore, York, Seward, Clay, Cedar, Thayer, Hamilton, Nance, Knox, Colfax, and Butler. See Appendix 4 for range and land cover analysis.

However, the species by all accounts is extremely rare. The U.S. Fish and Wildlife Service summarized curlew numbers in a recent Biological Opinion (USFWS 2012a) for the rodenticide chlorophacinone:

Recent quantitative methods used to evaluate the probability of the Eskimo curlew's existence have estimated extinction dates of 1967 and 1965, respectively, with the upper bounds of 95 percent confidence intervals in 1977 and 1970 (Elphick et al. 2010, FWS 2011e). These estimates are based on the last uncontroversial record of observance, a specimen that was shot in Barbados in 1963 (FWS 2011e). From 1963 to the spring of 2009, 39 potential sightings have occurred in 22 different years (Committee on the Status of Endangered Wildlife in Canada 2009); however, the reliability of these sightings is variable, and none have been confirmed by physical evidence (FWS 2011e). If controversial records of observance are included, then the analysis estimates an extinction date of 2008 with the upper bound of 95 percent confidence interval reaching 2013 (FWS 2011e).

In the case of chlorophacinone, EPA had initially made a “likely to adversely affect” determination for the curlew based on direct acute effects. This pesticide application involved potential large geographic areas of rangeland habitat, likely more favorable to curlews than maintained agricultural fields. The conclusion of the Biological Opinion was:

Eskimo curlews are likely already extinct or at best extremely rare; thus, direct and indirect effects from Rozol exposure are so highly unlikely to occur as to be considered discountable. Therefore, the Service does not anticipate adverse effects to Eskimo curlew from use of Rozol on BTPDs. No critical habitat for the Eskimo curlew has been designated; therefore none will be affected.

It is reasonable to reach a similar conclusion with dicamba DGA, a compound of likely lower acute toxic hazard than chlorophacinone and proposed for use on land cover more marginal for curlews than the chlorophacinone case. **Therefore the Agency determines that the proposed labeled use of dicamba DGA is “not likely to adversely affect” (NLAA) the Eskimo curlew because exposures are so highly unlikely to occur as to be considered discountable.**

EPA informally consulted with the U.S. Fish and Wildlife Service on the NLAA effects determination made for the Eskimo Curlew. The concurrence memo is appended in Appendix 6.

Herpifauna

Using birds as a surrogate for reptiles and terrestrial-phase amphibians, consistent with the Overview document (USEPA, 2004), the screening level assessment suggests that reptiles and terrestrial-phase amphibians could be at risk of effects from acute exposures to dicamba DGA or chronic exposures to DCSA on treated fields. Of the reptile and amphibian species identified as

potentially at acute risk in the seven states, one reptile and one amphibian are reasonably expected to occur on treated soybean and cotton fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

Eastern Indigo snake

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds/reptiles indicated concerns for acute effects to reptiles (using birds as a surrogate). The Eastern Indigo Snake is known or believed to occur in Alabama, Florida and Georgia (USFWS Species Profile Page, http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=C026). In Georgia, the species has been observed moving from sandhill habitat to the vicinity of agricultural fields in summer (Speake et al., 1978). Therefore, the species was determined to potentially occupy treated cotton and soybean fields and thus be subject to exposure to dicamba DGA on the treated field. The indigo snake feeds largely on other snakes, small tortoises, small mammals, and amphibians (USFWS, 1983). Using the conservative assumptions that the prey species is represented by a 35g mammal that feeds exclusively on contaminated short grass receiving the upper bound Kenaga residues from the spray application of dicamba and that the snake exclusively feeds on this prey species, the assumptions in the initial screen were adjusted to account for the indigo snake's biology:

Field metabolic rate kcal/day = $0.0530(4300)^{0.799} = 42.4$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the indigo snake from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $42.4 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.78 \text{ AE}) = 32 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.78 is assimilation efficiency from USEPA 1993, assumption of small mammal prey from the recovery plan (USFWS, 1983) and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013).

Mass of dicamba DGA in a 35-g mammal diet 173.26 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $32 \text{ g/day} \times 173.26 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 5.54 \text{ mg/day}$

Daily dose in snake = $5.54 \text{ mg dicamba DGA/day} / 4.3 = 1.29 \text{ mg/kg-bw/day}$

Appropriate scaling factors are not available for reptiles and amphibians so the acute toxicity value for the bobwhite quail (most sensitive avian species for which acute data are available) serves as a surrogate (USEPA, 2004) toxicity value for the tortoise:

Snake LD50 mg/kg-bw = **188 mg/kg-bw**

The RQ for acute effects = $1.29/188 = 0.007$

An acute RQ of 0.007 does not exceed the acute listed species LOC of 0.1. **Consequently, EPA makes a “no effect” determination for the indigo snake.**

DCSA Assessment for Eastern indigo snake consuming prey that had previously consumed soybean forage

The indigo snake feeds largely on other snakes, small tortoises, small mammals, and amphibians (USFWS, 1983). Using the conservative assumptions that the prey species is represented by a mammal that feeds exclusively on exposed soybean plant tissue containing the maximum measured DCSA residues of 61.1 ppm and that the snake exclusively feeds on this prey species, the assumptions in the initial screen were adjusted to account for the indigo snake's biology:

Field metabolic rate kcal/day = $0.0530(4300)^{0.799} = 42.4$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the indigo snake from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $42.4 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.78 \text{ AE}) = 32 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.78 is assimilation efficiency from USEPA 1993, assumption of small mammal prey from the recovery plan (USFWS, 1983) and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013).

Mass of DCSA in a mammal diet 61.1 mg/kg-ww (maximum empirical residue data on soybean forage)

Mass of DCSA in snake's daily diet = $32 \text{ g/day} \times 61.1 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 1.96 \text{ mg DCSA/day}$

Daily dose in snake = $1.96 \text{ mg DCSA/day} / 4.3 = \mathbf{0.46 \text{ mg/kg-bw/day}}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck (surrogate species for reptiles) study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

RQ for chronic exposure: $RQ = 0.46/40.88 = 0.01$

An RQ of 0.01 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Eastern indigo snake.**

Houston toad

Initial screening level risk assessment results for birds/terrestrial-phase amphibians indicated concerns for acute effects to amphibians (using birds as a surrogate). Historically, Houston toads ranged across the central coastal region of Texas in grassland/prairie ecosystems or in or near forested habitat and metamorphosed adult toads likely eat small terrestrial arthropods (USFWS, 2011b). As a conservative approach, EPA used the modeled upper bound T-REX residues for arthropods to evaluate the potential risk posed by dicamba applications at this time. This is considered a conservative approach as 100% of the toad's diet would be considered to consist of exposed arthropods receiving the upper bound Kenaga nomogram dicamba residues from the spray application. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $0.0530(45)^{0.799} = 1.1$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the Houston toad from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $1.1 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 0.9 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, insect diet assumption from USFWS, 2011b and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of dicamba DGA in insect diet 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $0.9 \text{ g/day} \times 102.99 \text{ mg dicamba DGA/kg-ww insect prey} \times 0.001 = 0.09 \text{ mg/day}$

Daily dose in toad = $0.09 \text{ mg dicamba DGA/day} / 0.045 = \mathbf{2.06 \text{ mg/kg-bw/day}}$

$$\text{Toad LD50 mg/kg-bw} = 188 \text{ mg/kg-bw} \times (45/178)^{(1.15-1)} = \mathbf{152.96 \text{ mg/kg-bw}}$$

(assumes the same scaling as for birds)

$$\text{The RQ for acute effects} = 2.06/152.96 = \mathbf{0.01}$$

An acute RQ of 0.01 does not exceed the acute listed species LOC of 0.1. **Consequently, EPA makes a “no effect” determination for the Houston toad.**

DCSA Assessment for Houston toad consuming prey that had previously consumed soybean forage

EFED considered DCSA residues in arthropods to be the maximum measured DCSA residues from broadleaf plants, modified by the Kenaga nomogram relationship between broadleaf plant and arthropods as a conservative pesticide load in the prey base. This is considered a conservative approach as 100% of the toad's diet would be considered to consist of exposed arthropods feeding on dicamba-tolerant soybean plants that had the highest measured DCSA residues. A biologically representative refinement to the screening assessment follows:

Field metabolic rate kcal/day = $0.0530(45)^{0.799} = 1.1 \text{ kcal/day}$
 (USEPA 1993, body weight reflects screening assumption for the Houston toad from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of prey consumed per day = $1.1 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.72 \text{ AE}) = 0.9 \text{ g/day}$
 (1.7 is energy content of prey item from USEPA (1993); 0.72 is assimilation efficiency from USEPA 1993, insect diet assumption from USFWS, 2011b and Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of DCSA in insect diet 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = $0.9 \text{ g/day} \times 42.5 \text{ mg dicamba DGA/kg-ww insect prey} \times 0.001 = 0.038 \text{ mg/day}$

Daily dose in toad = $0.038 \text{ mg DCSA/day} / 0.045 = \mathbf{0.85 \text{ mg/kg-bw/day}}$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck (surrogate species for terrestrial-phase amphibians) study for parent dicamba) modified by ratio of parent

dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of 40.88 mg/kg-diet.

RQ for chronic exposure: $RQ = 0.85/40.88 = 0.02$

An RQ of 0.02 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Houston toad.**

Mammals

The screening-level assessments indicated that acute risk to mammals was not expected as no acute RQs exceeded the Agency’s LOC (0.1) for acute risk (USEPA 2011. D378444, p. 15). However, the soybean screening-level assessment (USEPA, 2011) indicated that mammals could be at reproductive risk from chronic exposures to dicamba DGA on treated fields, though the cotton screening level and concurrently issued soybean addendum (USEPA, 2016a and USEPA, 2016b) indicated that chronic exposures to dicamba DGA would be below the chronic LOC (1.0). This difference is due to soybean screening level risk assessment’s use of a chronic endpoint from the rat 2-generation study (MRID 43137101), of 45 mg/kg-bw for the NOAEL, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016c; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, as pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. Therefore, the cotton screening level risk assessment, the concurrently issued soybean addendum and this refined endangered species risk assessment use this revised NOAEL for dicamba DGA salt.

The concurrently issued soybean addendum did indicate that chronic exposures to dicamba’s metabolite, DCSA, residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency’s LOC for chronic risk. Therefore, EPA only conducted a refined assessment for chronic exposures to DCSA in soybeans for listed species that could reasonably be expected to occur on treated soybean fields.

Of the mammalian species identified as potentially at risk in the seven states, four are reasonably expected to occur on treated soybean fields. Species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for the four species potentially expected to occur on treated soybean fields.

Virginia big-eared bat

Dicamba Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects to mammals. This bat is assumed to potentially forage over treated fields and thus be subject to exposure to dicamba DGA on the treated field. Big-eared bats feed principally on small moths and other insects (USFWS, 1984). Exposure assumptions from the screening assessment were refined to account for the Virginia big-eared bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods having received the upper bound Kenaga residues from the spray application of dicamba.

Field metabolic rate kcal/day = $0.6167(7\text{g})^{0.862} = 3.3$ kcal/day
(USEPA 1993, body weight 7 g reflects screening assumption for the bat USFWS 2014a;
<http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A080>)

Mass of prey consumed per day = $(3.3 \text{ kcal/day}) / (1.7 \text{ kcal/g ww} \times 0.87 \text{ AE}) = 2.2$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.87 is assimilation efficiency from USEPA 1993)

Mass of dicamba DGA in insect diet = 102.99 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $2.2 \text{ g/day} \times 102.99 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 0.23$ mg/day

Daily dose in bat = $0.23 \text{ mg dicamba DGA/day} / 0.007 \text{ kg} = \mathbf{32.37 \text{ mg/kg-bw/day}}$

Bat NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/7)^{0.25} = \mathbf{361.64 \text{ mg/kg-bw}}$

RQ for chronic exposure = $\text{RQ} = 32.37 / 361.64 = \mathbf{0.09}$

A chronic RQ of 0.09 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the the Virginia big-eared bat.**

DCSA Assessment for Virginia big-eared bat consuming prey that had previously consumed soybean forage

Initial screening level risk assessment results for the Virginia big-eared bat were refined to account for the bat's biology and contained the conservative assumption that bats would feed exclusively on exposed insects/arthropods feeding on dicamba-tolerant soybean plant tissues that had the highest measured DCSA residues.

Field metabolic rate kcal/day = $0.6167(7\text{g})^{0.862} = 3.3$ kcal/day

(USEPA 1993, body weight 7 g reflects screening assumption for the bat USFWS 2014a; <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?scode=A080>)

Mass of prey consumed per day = (3.3 kcal/day)/(1.7 kcal/g ww X 0.87 AE) = 2.2 g/day (1.7 is energy content of prey item from USEPA (1993); 0.87 is assimilation efficiency from USEPA 1993)

Mass of DCSA in insect diet = 42.5 mg/kg-ww (conservative assumption of Kenaga nomogram relationship between arthropod residues and broadleaf plant tissue residues based on 61.1 mg/kg maximum value from empirical data for soybean forage)

Mass of DCSA in daily diet = 2.2 g/day X 42.5 mg DCSA/kg-ww mammal prey X 0.001 = 0.094 mg/day

Daily dose in bat = 0.094 mg DCSA/day/0.007 kg = **13.357 mg/kg-bw/day**

Bat NOAEL mg/kg-bw/day = 8 mg/kg-bw X (350/7)^{0.25} = **21.27 mg/kg-bw**

RQ for chronic exposure = RQ = 13.357/21.27 = **0.63**

A chronic RQ of 0.63 does not exceed the chronic LOC of 1.0; **consequently a “no effect” determination is concluded for the Virginia big-eared bat.**

Ocelot

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects to mammals. The recovery plan for the ocelot (USFWS, 1990, revised 2010) describes the ocelot's habitat in Texas as dense thornscrub communities on Laguna Atascosa National Wildlife Refuge and on private lands in three Texas counties. The ocelot requires dense vegetation (>75% canopy cover), with 95% cover of the shrub layer preferred in Texas and it feeds primarily on rabbits, rodents, birds and lizards (USFWS, 1990). Although this indicates the ocelot is unlikely to inhabit agricultural row crop areas, the prey species it feeds on could be exposed in soybean or cotton fields and then subsequently consumed by the ocelot away from the field. Using the assumption that the prey species is represented by a 1000 g mammal (conservative as to rabbits) and using the conservative assumptions that the prey feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for ocelot's biology:

Field metabolic rate kcal/day = $0.6167(16000)^{0.862} = 2594$ kcal/day

(USEPA 1993, body weight reflects screening assumption for the ocelot from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of prey consumed per day = $2594 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 1816 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, mammal diet assumption from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of dicamba DGA in 1kg mammal diet 40.17 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $1816 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 72.95 \text{ mg/day}$

Daily dose in ocelot = $72.95 \text{ mg dicamba DGA/day} / 16 = \mathbf{4.56 \text{ mg/kg-bw/day}}$

Ocelot NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} (350/16000)^{(0.25)} = \mathbf{52.30 \text{ mg/kg-bw}}$

The RQ for chronic effects = $4.56/52.30 = \mathbf{0.09}$

A chronic RQ of 0.09 does not exceed the chronic LOC of 1.0. Even if the ocelot were assumed to consume a smaller (35-g mammal) prey species that had consumed exposed short grass (T-REX modeled residues of 173.26 mg/kg-ww), the chronic RQ (0.38) would still be below the LOC. **Consequently, EPA makes a “no effect” determination for the ocelot.**

DCSA Assessment for Ocelot consuming prey that had previously consumed exposed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56 \text{ g/day}$

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8 \text{ g/day}$

DCSA residue in prey eating soybean forage/hay $61.1 \text{ mg DCSA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{9.34 \text{ mg/kg-bw/day}}$

The next step is to determine the expected daily dose for a typical 16 kg ocelot, the adjusted NOAEL value and the chronic dose-based RQ for the ocelot based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(16000)^{0.862} = 2594$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the ocelot from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of prey consumed per day = $2594 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 1816$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, mammal diet assumption from Recovery Plan (USFWS 1990; http://ecos.fws.gov/docs/recovery_plan/100826.pdf))

Mass of DCSA in 1kg mammal diet 9.34 mg/kg-ww (based on allometric equations above and maximum empirical residue data on soybean forage)

Mass of DCSA in daily diet = $1816 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 16.96$ mg/day

Daily dose in ocelot = $16.96 \text{ mg DCSA/day} / 16 = \mathbf{1.060 \text{ mg/kg-bw/day}}$

Ocelot NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} (350/16000)^{(0.25)} = \mathbf{3.08 \text{ mg/kg-bw}}$

The RQ for chronic effects = $1.06/3.08 = 0.35$

A chronic RQ of 0.35 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “No Effect” determination for the ocelot.**

Gulf Coast jaguarundi

Initial screening level risk assessment results for mammals identified concerns for chronic effects. The recovery plan for the jaguarundi (USFWS, 2012b) describes the species as using dense thorny shrublands or woodlands and bunchgrass pastures adjacent to dense brush or woody cover and preying mainly on birds, small mammals, and reptiles. Although this indicates the jaguarundi is unlikely to inhabit agricultural row crop areas, the prey species it feeds on could be exposed in soybean or cotton fields and then subsequently consumed by the jaguarundi away from the field. Using the assumptions that the prey species is represented by a 1000 g mammal and using the conservative assumptions that the prey feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba,

exposure assumptions from the screening assessment were adjusted to account for the jaguarundi's biology:

Field metabolic rate kcal/day = $0.6167(90000)^{0.862} = 11498$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguarundi from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of prey consumed per day = $11498 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 8051$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of dicamba DGA in 1 kg mammal diet 40.17 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $8051 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 323$ mg/day

Daily dose in jaguarundi = $323 \text{ mg dicamba DGA/day} / 90 = \mathbf{3.59 \text{ mg/kg-bw/day}}$

Jaguarundi NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/90000)^{(0.25)} = \mathbf{33.96 \text{ mg/kg-bw}}$

The RQ for chronic effects = $3.59/33.96 = \mathbf{0.11}$.

A chronic RQ of 0.11 does not exceed the chronic LOC of 1.0. Even if the jaguarundi were assumed to consume a smaller (35-g mammal) prey species that had consumed exposed short grass (T-REX modeled residues of 173.26 mg/kg-ww), the chronic RQ (0.46) would still be below the LOC. **Consequently, EPA makes a “no effect” determination for the jaguarundi.**

DCSA Assessment for Jaguarundi consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56$ g/day

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 90 kg jaguarundi, the adjusted NOAEL value and the chronic dose-based RQ for the ocelot based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(90000)^{0.862} = 11498$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguarundi from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of prey consumed per day = $11498 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 8051$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012b)
(http://www.fws.gov/southwest/es/Documents/R2ES/Gulf_Coast_Jaguarundi_DRAFT_Recovery_Plan_24Dec2012.pdf)

Mass of DCSA in 1 kg mammal diet 9.34 mg/kg-ww (based on allometric equations above and maximum empirical DCSA residues on soybean forage)

Mass of DCSA in daily diet = $8051 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 75.20$ mg/day

Daily dose in jaguarundi = $75.20 \text{ mg DCSA/day} / 90 = \mathbf{0.84 \text{ mg/kg-bw/day}}$

Jaguarundi NOAEL mg/kg-bw/day = $4 \text{ mg/kg-bw} \times (350/90000)^{(0.25)} = \mathbf{2.00 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.84/2.00 = \mathbf{0.42}$.

A chronic RQ of 0.42 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the jaguarundi.**

Red wolf

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Since 1987, reintroduced red wolves have been identified in a variety of habitats including wetlands, pine forests, upland shrubs, and cropland (USFWS, 2007). The diet of red

wolves is primarily white-tailed deer, but they may also eat smaller mammals such as raccoons, rabbits and mice (Whitaker and Hamilton, 1998). Using the conservative assumptions that the prey species is represented by a 1000 g mammal (conservative for deer, raccoons and rabbits) that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the red wolf's biology, specifically their consumption of other mammals that may have been exposed to dicamba DGA residues in cotton and soybean fields.

Field metabolic rate kcal/day = $0.6167(36000)^{0.862} = 5219$ kcal/day (USEPA 1993, body weight reflects screening assumption for the red wolf from Whitaker and Hamilton (1998))

Mass of prey consumed per day = $5219 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 3654$ g/day (1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Whitaker and Hamilton (1998))

Mass of dicamba DGA in 1 kg mammal diet 40.17 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $3654 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 147$ mg/day

Daily dose in wolf = $147 \text{ mg dicamba DGA/day} / 36 = \mathbf{4.08 \text{ mg/kg-bw/day}}$

Wolf NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/36000)^{(0.25)} = \mathbf{42.71 \text{ mg/kg-bw}}$

The RQ for chronic effects = $4.08/42.71 = \mathbf{0.10}$.

A chronic RQ of 0.10 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the red wolf.**

DCSA Assessment for red wolf consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56$ g/day

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 36 kg wolf, the adjusted NOAEL value and the chronic dose-based RQ for the wolf based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(36000)^{0.862}$ = 5219 kcal/day (USEPA 1993, body weight reflects screening assumption for the red wolf from Whitaker and Hamilton (1998))

Mass of prey consumed per day = 5219 kcal/day/(1.7 kcal/g ww X 0.84 AE) = 3654 g/day (1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Whitaker and Hamilton (1998))

Mass of DCSA in 1 kg mammal diet 9.34 mg/kg-ww from allometric equations above and maximum empirical residue data.

Mass of DCSA in daily diet = 3654 g/day X 9.34 mg DCSA/kg-ww mammal prey X 0.001 = 34.13 mg/day

Daily dose in wolf = 34.13 mg dicamba DGA/day/36 = **0.95 mg/kg-bw/day**

Wolf NOAEL mg/kg-bw/day = 8 mg/kg-bw X $(350/36000)^{(0.25)}$ = **2.51 mg/kg-bw**

The RQ for chronic effects = 0.95/2.51 = **0.38**

A chronic RQ of 0.38 does not exceed the chronic LOC of 1.0. **Consequently, EPA makes a “no effect” determination for the red wolf.**

Critical Habitat Determinations

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis consistent with the Overview Document as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife Service or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species. The Agency will conclude 'modification' of designated critical habitat if the range of designated critical habitat co-occurs with the states subject to the Federal action and one or more of the following conditions exist:

1. The available Services' information indicates that cotton or soybean fields are habitat for the species and there is a "may affect" determination for the species associated with exposure to dicamba DGA salt or its degradate, DCSA, as labeled.
2. The available Services' information indicates that the species uses cotton or soybean fields and one or more effects on taxonomic groups predicted for dicamba DGA salt or its degradate DCSA, on cotton and soybean fields would modify one or more of the designated PCEs.

If neither of the above conditions are met, EPA concludes "no modification."

Results of Analysis

Of the 307 listed species within the states, there are 292 species identified in the effects determinations as not using cotton or soybean fields and 14 species using these fields (**Appendix 5**). Critical habitats have been designated for 118 of the 307 species. One-hundred thirteen (113) species with critical habitat were judged to not use cotton or soybean fields and so the critical habitat determination for these was "no modification."

The remaining 5 species with critical habitat designations were assumed to use cotton or soybean fields and so the previous listed species effects determinations were consulted to ascertain if any were determined to be at risk for direct adverse effects. None of the species were determined to be at risk for direct adverse effects, so the PCE's listed in the Services' critical habitat designations were consulted to determine if, in light of the screening assessment risk findings, they would be impacted by on-field exposure to dicamba DGA salt. For all but one of these species, the PCE's are not relatable to agricultural fields and so a determination of no modification has been made for these 4 species.

The only remaining species using cotton or soybean fields and with critical habitat PCE's relatable to agricultural fields was the whooping crane, for which agricultural fields were discussed as providing waste grain as a potential food source for migratory cranes. The only way the proposed dicamba DGA salt could affect this PCE is by making grain potentially toxic to the birds. As there is unlikely to be any edible waste grain remaining following cotton harvesting, it is unlikely that the proposed dicamba DGA salt use on cotton could affect this PCE, however the proposed use on soybean could affect this PCE by making waste soybean grain potentially toxic.

The Health Effects Division summarized available soybean grain residues of dicamba in the Human Health Risk Assessment for the Registration Eligibility Decision for Dicamba and Associated Salts (DP317703). Based on the soybean trials results, maximum residues of dicamba were 0.04 ppm in hay, 0.097 ppm in forage, and 8.13 ppm in seed 6-8 days post treatment (MRIDs 43814101 and 44089307). These measured values were used to set the tolerance value of 10 ppm for soybean seeds. The measured residues are not reasonably expected to be at a level

raising a concern for direct effects to the whooping crane because the direct effects assessment for this species (presented in the Section 3 Risk Assessment Refined Endangered Species Assessment that assessed risks to endangered species in 16 states (Arkansas, Kansas, Louisiana, Illinois, Indiana, Iowa, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin {DP 416416, 420160, 420159, 420352, 421434, 421723})) did not establish a concern for residues in other dietary items at much **higher** (~ 1 order of magnitude) concentrations than would occur at the maximum measured residues in seed or if residues were present even at the tolerance level of 10.0 ppm. Because this analysis shows no direct effects of dicamba at levels that would be expected in the fields as waste grain, an indirect effect, there is no modification of critical habitat. Similarly, measured DCSA residues in waste soybean grain (0.44 ppm) would be well below the estimated DCSA concentrations in arthropods (42.5 ppm) used in the direct effects assessment for this species (D416516+, pp. 9-10). Therefore, whooping crane critical habitat within the 7 states covered in this assessment would not be modified.

Summary of Determinations for Critical Habitat

The Agency has determined that the proposed labeled use of dicamba DGA salt on cotton and soybeans will not modify designated critical habitat for all 118 species for which such habitats have been designated in AL, GA, KY, MI, NC, SC, and TX.

A summary of listed species identified as not being on agricultural fields with and without critical habitat designations for the seven states assessed for dicamba DGA salt is provided in **Appendix 5**.

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Appendix 1

Threatened and Endangered Species in Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas

Common Name	Scientific Name	Taxon
Indiana bat	<i>Myotis sodalis</i>	Mammal
West Indian Manatee	<i>Trichechus manatus</i>	Mammal
Finback whale	<i>Balaenoptera physalus</i>	Mammal
Humpback whale	<i>Megaptera novaeangliae</i>	Mammal
Gray bat	<i>Myotis grisescens</i>	Mammal
Canada Lynx	<i>Lynx canadensis</i>	Mammal
Louisiana black bear	<i>Ursus americanus luteolus</i>	Mammal
Carolina northern flying squirrel	<i>Glaucomys sabrinus coloratus</i>	Mammal
Whooping crane	<i>Grus americana</i>	Bird
Eskimo curlew	<i>Numenius borealis</i>	Bird
Kirtland's Warbler	<i>Setophaga kirtlandii</i>	Bird
Red-cockaded woodpecker	<i>Picoides borealis</i>	Bird
Wood stork	<i>Mycteria americana</i>	Bird
Piping Plover	<i>Charadrius melodus</i>	Bird
Least tern	<i>Sterna antillarum</i>	Bird
Black-capped Vireo	<i>Vireo atricapilla</i>	Bird
Lesser Prairie-Chicken	<i>Tympanuchus pallidicinctus</i>	Bird
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Reptile
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Reptile
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Reptile
Green sea turtle	<i>Chelonia mydas</i>	Reptile
Alabama red-belly turtle	<i>Pseudemys alabamensis</i>	Reptile
Copperbelly water snake	<i>Nerodia erythrogaster neglecta</i>	Reptile
Gopher tortoise	<i>Gopherus polyphemus</i>	Reptile
Snail darter	<i>Percina tanasi</i>	Fish
Spotfin Chub	<i>Erimonax monachus</i>	Fish
Slackwater darter	<i>Etheostoma boschungii</i>	Fish
Gulf sturgeon	<i>Acipenser oxyrinchus desotoi</i>	Fish
Amber darter	<i>Percina antesella</i>	Fish
Conasauga logperch	<i>Percina jenkinsi</i>	Fish
Blackside dace	<i>Phoxinus cumberlandensis</i>	Fish
Boulder darter	<i>Etheostoma wapiti</i>	Fish
Cumberland darter	<i>Etheostoma susanae</i>	Fish
Arkansas River shiner	<i>Notropis girardi</i>	Fish
Blue shiner	<i>Cyprinella caerulea</i>	Fish
Smalleye Shiner	<i>Notropis buccula</i>	Fish
Pallid sturgeon	<i>Scaphirhynchus albus</i>	Fish
Duskytail darter	<i>Etheostoma percnurum</i>	Fish
Cumberland bean (pearlymussel)	<i>Villosa trabalis</i>	Bivalve

purple cat's paw (=purple cat's paw pearlymussel)	<i>Epioblasma obliquata obliquata</i>	Bivalve
Alabama lampmussel	<i>Lampsilis virescens</i>	Bivalve
Pale lilliput (pearlymussel)	<i>Toxolasma cylindrellus</i>	Bivalve
Cumberland monkeyface (pearlymussel)	<i>Quadrula intermedia</i>	Bivalve
Pink mucket (pearlymussel)	<i>Lampsilis abrupta</i>	Bivalve
Dromedary pearlymussel	<i>Dromus dromas</i>	Bivalve
Littlewing pearlymussel	<i>Pegias fabula</i>	Bivalve
White wartyback (pearlymussel)	<i>Plethobasus cicatricosus</i>	Bivalve
Finerayed pigtoe	<i>Fusconaia cuneolus</i>	Bivalve
Rough pigtoe	<i>Pleurobema plenum</i>	Bivalve
Shiny pigtoe	<i>Fusconaia cor</i>	Bivalve
Orangefoot pimpleback (pearlymussel)	<i>Plethobasus cooperianus</i>	Bivalve
Fat pocketbook	<i>Potamilus capax</i>	Bivalve
Spectaclecase (mussel)	<i>Cumberlandia monodonta</i>	Bivalve
Southern combshell	<i>Epioblasma penita</i>	Bivalve
Rayed Bean	<i>Villosa fabalis</i>	Bivalve
Clubshell	<i>Pleurobema clava</i>	Bivalve
Cumberlandian combshell	<i>Epioblasma brevidens</i>	Bivalve
Appalachian elktoe	<i>Alasmidonta raveneliana</i>	Bivalve
Alabama (=inflated) heelsplitter	<i>Potamilus inflatus</i>	Bivalve
Orangenacre mucket	<i>Lampsilis perovalis</i>	Bivalve
Oyster mussel	<i>Epioblasma capsaeformis</i>	Bivalve
Slabside Pearlymussel	<i>Pleuroaia dolabelloides</i>	Bivalve
Stirrupshell	<i>Quadrula stapes</i>	Bivalve
Fanshell	<i>Cyprogenia stegaria</i>	Bivalve
Finelined pocketbook	<i>Lampsilis altalis</i>	Bivalve
Northern riffleshell	<i>Epioblasma torulosa rangiana</i>	Bivalve
Ovate clubshell	<i>Pleurobema perovatum</i>	Bivalve
Southern clubshell	<i>Pleurobema decisum</i>	Bivalve
Triangular Kidneyshell	<i>Ptychobranhus greenii</i>	Bivalve
Alabama moccasinshell	<i>Medionidus acutissimus</i>	Bivalve
Coosa moccasinshell	<i>Medionidus parvulus</i>	Bivalve
Southern pigtoe	<i>Pleurobema georgianum</i>	Bivalve
Snuffbox mussel	<i>Epioblasma triquetra</i>	Bivalve
Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	Bivalve
Georgia pigtoe	<i>Pleurobema hanleyianum</i>	Bivalve
Fluted kidneyshell	<i>Ptychobranhus subtentum</i>	Bivalve
Sheepnose Mussel	<i>Plethobasus cyphus</i>	Bivalve
Anthony's riversnail	<i>Athearnia anthonyi</i>	Gastropod
Karner blue butterfly	<i>Lycaeides melissa samuelis</i>	Insect
Mitchell's satyr Butterfly	<i>Neonympha mitchellii mitchellii</i>	Insect
American burying beetle	<i>Nicrophorus americanus</i>	Insect
Hine's emerald dragonfly	<i>Somatochlora hineana</i>	Insect
Spruce-fir moss spider	<i>Microhexura montivaga</i>	Arachnid

Short's bladderpod	<i>Physaria globosa</i>	Dicot
Price's potato-bean	<i>Apios priceana</i>	Dicot
Braun's rock-cress	<i>Arabis perstellata</i>	Dicot
Cumberland rosemary	<i>Conradina verticillata</i>	Dicot
No common name	<i>Geocarpum minimum</i>	Dicot
Spreading avens	<i>Geum radiatum</i>	Dicot
Small whorled pogonia	<i>Isotria medeoloides</i>	Monocot
Short's goldenrod	<i>Solidago shortii</i>	Dicot
Cumberland sandwort	<i>Arenaria cumberlandensis</i>	Dicot
Pitcher's thistle	<i>Cirsium pitcheri</i>	Dicot
Leafy prairie-clover	<i>Dalea foliosa</i>	Dicot
Roan Mountain bluet	<i>Hedyotis purpurea</i> var. <i>montana</i>	Dicot
Dwarf lake iris	<i>Iris lacustris</i>	Monocot
Pondberry	<i>Lindera melissifolia</i>	Dicot
Eastern prairie fringed orchid	<i>Platanthera leucophaea</i>	Monocot
Harperella	<i>Ptilimnium nodosum</i>	Dicot
American chaffseed	<i>Schwalbea americana</i>	Dicot
Large-flowered skullcap	<i>Scutellaria montana</i>	Dicot
Blue Ridge goldenrod	<i>Solidago spithamea</i>	Dicot
Tennessee yellow-eyed grass	<i>Xyris tennesseensis</i>	Monocot
Virginia spiraea	<i>Spiraea virginiana</i>	Dicot
Running buffalo clover	<i>Trifolium stoloniferum</i>	Dicot
Lakeside daisy	<i>Hymenoxys herbacea</i>	Dicot
Morefield's leather flower	<i>Clematis morefieldii</i>	Dicot
Whorled Sunflower	<i>Helianthus verticillatus</i>	Dicot
American hart's-tongue fern	<i>Asplenium scolopendrium</i> var. <i>americanum</i>	Ferns
Louisiana quillwort	<i>Isoetes louisianensis</i>	Ferns
Rock gnome lichen	<i>Gymnoderma lineare</i>	Lichen
Red wolf	<i>Canis rufus</i>	Mammal
North Atlantic Right Whale	<i>Eubalaena glacialis</i>	Mammal
Sperm whale	<i>Physeter catodon</i> (= <i>macrocephalus</i>)	Mammal
Gulf Coast jaguarundi	<i>Herpailurus</i> (= <i>Felis</i>) <i>yagouaroundi cacomitli</i>	Mammal
Virginia big-eared bat	<i>Corynorhinus</i> (= <i>Plecotus</i>) <i>townsendii virginianus</i>	Mammal
Ocelot	<i>Leopardus</i> (= <i>Felis</i>) <i>pardalis</i>	Mammal
Perdido Key beach mouse	<i>Peromyscus polionotus trissyllepsis</i>	Mammal
Alabama beach mouse	<i>Peromyscus polionotus ammobates</i>	Mammal
Mexican long-nosed bat	<i>Leptonycteris nivalis</i>	Mammal
Attwater's greater prairie-chicken	<i>Tympanuchus cupido attwateri</i>	Bird
Bachman's warbler (=wood)	<i>Vermivora bachmanii</i>	Bird
Northern aplomado falcon	<i>Falco femoralis septentrionalis</i>	Bird
Mexican spotted owl	<i>Strix occidentalis lucida</i>	Bird
Roseate tern	<i>Sterna dougallii dougallii</i>	Bird

Golden-cheeked warbler (=wood)	<i>Dendroica chrysoparia</i>	Bird
Southwestern willow flycatcher	<i>Empidonax traillii extimus</i>	Bird
Loggerhead sea turtle	<i>Caretta caretta</i>	Reptile
Flattened musk turtle	<i>Sternotherus depressus</i>	Reptile
Eastern indigo snake	<i>Drymarchon corais couperi</i>	Reptile
Texas blind salamander	<i>Typhlomolge rathbuni</i>	Amphibian
Houston toad	<i>Bufo houstonensis</i>	Amphibian
Red Hills salamander	<i>Phaeognathus hubrichti</i>	Amphibian
San Marcos salamander	<i>Eurycea nana</i>	Amphibian
Barton Springs salamander	<i>Eurycea sosorum</i>	Amphibian
Frosted Flatwoods salamander	<i>Ambystoma cingulatum</i>	Amphibian
Jollyville Plateau salamander	<i>Eurycea tonkawae</i>	Amphibian
Georgetown salamander	<i>Eurycea naufragia</i>	Amphibian
Salado salamander	<i>Eurycea chisholmensis</i>	Amphibian
Austin blind salamander	<i>Eurycea waterlooensis</i>	Amphibian
Reticulated flatwoods salamander	<i>Ambystoma bishopi</i>	Amphibian
Big Bend gambusia	<i>Gambusia gaigei</i>	Fish
Clear Creek gambusia	<i>Gambusia heterochir</i>	Fish
Comanche Springs pupfish	<i>Cyprinodon elegans</i>	Fish
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Fish
Fountain darter	<i>Etheostoma fonticola</i>	Fish
Watercress darter	<i>Etheostoma nuchale</i>	Fish
Pecos gambusia	<i>Gambusia nobilis</i>	Fish
Alabama cavefish	<i>Speoplatyrhinus poulsoni</i>	Fish
Pygmy Sculpin	<i>Cottus paulus (=pygmaeus)</i>	Fish
Cape Fear shiner	<i>Notropis mekistocholas</i>	Fish
Waccamaw silverside	<i>Menidia extensa</i>	Fish
San Marcos gambusia	<i>Gambusia georgei</i>	Fish
Leon Springs pupfish	<i>Cyprinodon bovinus</i>	Fish
Alabama sturgeon	<i>Scaphirhynchus suttkusi</i>	Fish
Cherokee darter	<i>Etheostoma scotti</i>	Fish
Devils River minnow	<i>Dionda diaboli</i>	Fish
Cahaba shiner	<i>Notropis cahabae</i>	Fish
Palezone shiner	<i>Notropis albizonatus</i>	Fish
Sharpnose Shiner	<i>Notropis oxyrhynchus</i>	Fish
Sunfish, spring pygmy	<i>Elassoma alabamae</i>	Fish
Goldline darter	<i>Percina aurolineata</i>	Fish
Relict darter	<i>Etheostoma chienense</i>	Fish
Etowah darter	<i>Etheostoma etowahae</i>	Fish
Vermilion darter	<i>Etheostoma chermocki</i>	Fish
Smalltooth sawfish	<i>Pristis pectinata</i>	Fish
Rush Darter	<i>Etheostoma phytophilum</i>	Fish
Yellow blossom (pearlymussel)	<i>Epioblasma florentina florentina</i>	Bivalve
Ring pink (mussel)	<i>Obovaria retusa</i>	Bivalve
Flat pigtoe	<i>Pleurobema marshalli</i>	Bivalve

Heavy pigtoe	<i>Pleurobema taitianum</i>	Bivalve
Tar River spinymussel	<i>Elliptio steinstansana</i>	Bivalve
Choctaw bean	<i>Villosa choctawensis</i>	Bivalve
Cumberland elktoe	<i>Alasmodonta atropurpurea</i>	Bivalve
Alabama pearlshell	<i>Margaritifera marrianae</i>	Bivalve
Cracking pearlymussel	<i>Hemistena lata</i>	Bivalve
James spinymussel	<i>Pleurobema collina</i>	Bivalve
Altamaha Spinymussel	<i>Elliptio spinosa</i>	Bivalve
Dwarf wedgemussel	<i>Alasmodonta heterodon</i>	Bivalve
Southern acornshell	<i>Epioblasma othcaloogensis</i>	Bivalve
Purple bankclimber (mussel)	<i>Elliptoideus sloatianus</i>	Bivalve
Upland combshell	<i>Epioblasma metastrata</i>	Bivalve
Round Ebonyshell	<i>Fusconaia rotulata</i>	Bivalve
Carolina heelsplitter	<i>Lasmigona decorata</i>	Bivalve
Southern kidneyshell	<i>Ptychobranhus jonesi</i>	Bivalve
Oval pigtoe	<i>Pleurobema pyriforme</i>	Bivalve
Narrow pigtoe	<i>Fusconaia escambia</i>	Bivalve
Shinyrayed pocketbook	<i>Lampsilis subangulata</i>	Bivalve
Southern sandshell	<i>Hamiota (=Lampsilis) australis</i>	Bivalve
Fat three-ridge (mussel)	<i>Amblema neislerii</i>	Bivalve
Dark pigtoe	<i>Pleurobema furvum</i>	Bivalve
Gulf moccasinshell	<i>Medionidus penicillatus</i>	Bivalve
Ochlockonee moccasinshell	<i>Medionidus simpsonianus</i>	Bivalve
Chipola slabshell	<i>Elliptio chipolaensis</i>	Bivalve
Fuzzy pigtoe	<i>Pleurobema strodeanum</i>	Bivalve
Tapered pigtoe	<i>Fusconaia burkei</i>	Bivalve
Noonday globe	<i>Patera clarki nantahala</i>	Gastropod
Phantom springsnail	<i>Pyrgulopsis texana</i>	Gastropod
Phantom tryonia	<i>Tryonia cheatumi</i>	Gastropod
Armored snail	<i>Pyrgulopsis (=Marstonia) pachyta</i>	Gastropod
Pecos assiminea snail	<i>Assiminea pecos</i>	Gastropod
Diamond Y Spring snail	<i>Pseudotryonia adamantina</i>	Gastropod
Tulotoma snail	<i>Tulotoma magnifica</i>	Gastropod
Gonzales springsnail	<i>Tryonia circumstriata</i>	Gastropod
Lacy elimia (snail)	<i>Elimia crenatella</i>	Gastropod
Rough hornsnail	<i>Pleurocera foremani</i>	Gastropod
Cylindrical lioplax (snail)	<i>Lioplax cyclostomaformis</i>	Gastropod
Flat pebblesnail	<i>Lepyrium showalteri</i>	Gastropod
Painted rocksnail	<i>Leptoxis taeniata</i>	Gastropod
Plicate rocksnail	<i>Leptoxis plicata</i>	Gastropod
Round rocksnail	<i>Leptoxis ampla</i>	Gastropod
Slender campeloma	<i>Campeloma decampi</i>	Gastropod
Interrupted (=Georgia) Rocksnail	<i>Leptoxis foremani</i>	Gastropod
Hungerford's crawling water Beetle	<i>Brychius hungerfordi</i>	Insect
Coffin Cave mold beetle	<i>Batrisodes texanus</i>	Insect

Kretschmarr Cave mold beetle	<i>Texamaurops reddelli</i>	Insect
Tooth Cave ground beetle	<i>Rhadine persephone</i>	Insect
Comal Springs riffle beetle	<i>Heterelmis comalensis</i>	Insect
Comal Springs dryopid beetle	<i>Stygoparnus comalensis</i>	Insect
Saint Francis' satyr butterfly	<i>Neonympha mitchellii francisci</i>	Insect
[Unnamed] ground beetle	<i>Rhadine infernalis</i>	Insect
Helotes mold beetle	<i>Batrisodes venyivi</i>	Insect
[Unnamed] ground beetle	<i>Rhadine exilis</i>	Insect
Bee Creek Cave harvestman	<i>Texella reddelli</i>	Arachnid
Bone Cave harvestman	<i>Texella reyesi</i>	Arachnid
Tooth Cave pseudoscorpion	<i>Tartarocreagris texana</i>	Arachnid
Tooth Cave Spider	<i>Leptoneta myopica</i>	Arachnid
Cokendolpher Cave Harvestman	<i>Texella cokendolpheri</i>	Arachnid
Government Canyon Bat Cave Spider	<i>Neoleptoneta microps</i>	Arachnid
Madla's Cave Meshweaver	<i>Cicurina madla</i>	Arachnid
Robber Baron Cave Meshweaver	<i>Cicurina baronia</i>	Arachnid
Government Canyon Bat Cave Meshweaver	<i>Cicurina vespera</i>	Arachnid
Braken Bat Cave Meshweaver	<i>Cicurina venii</i>	Arachnid
Peck's cave amphipod	<i>Stygobromus (=Stygonectes) pecki</i>	Crustacean
Alabama cave shrimp	<i>Palaemonias alabamiae</i>	Crustacean
Kentucky cave shrimp	<i>Palaemonias ganteri</i>	Crustacean
Diminutive Amphipod	<i>Gammarus hyalleloides</i>	Crustacean
Star cactus	<i>Astrophytum asterias</i>	Dicot
Pecos (=puzzle, =paradox) sunflower	<i>Helianthus paradoxus</i>	Dicot
Neches River rose-mallow	<i>Hibiscus dasycalyx</i>	Dicot
Kentucky glade cress	<i>Leavenworthia exigua laciniata</i>	Dicot
Fleshy-Fruit Gladecress	<i>Leavenworthia crassa</i>	Dicot
Zapata bladderpod	<i>Lesquerella thamnophila</i>	Dicot
Ashy dogweed	<i>Thymophylla tephroleuca</i>	Dicot
South Texas ambrosia	<i>Ambrosia cheiranthifolia</i>	Dicot
Little amphianthus	<i>Amphianthus pusillus</i>	Dicot
Tobusch fishhook cactus	<i>Sclerocactus brevihamatus ssp. tobuschii</i>	Dicot
Hairy rattleweed	<i>Baptisia arachnifera</i>	Dicot
Texas poppy-mallow	<i>Callirhoe scabriuscula</i>	Dicot
Small-anthered bittercress	<i>Cardamine micranthera</i>	Dicot
Nellie cory cactus	<i>Coryphantha minima</i>	Dicot
Bunched cory cactus	<i>Coryphantha ramillosa</i>	Dicot
Sneed pincushion cactus	<i>Coryphantha sneedii var. sneedii</i>	Dicot
Black lace cactus	<i>Echinocereus reichenbachii var. albertii</i>	Dicot
Davis' green pitaya	<i>Echinocereus viridiflorus var. davisii</i>	Dicot
Lloyd's Mariposa cactus	<i>Echinomastus mariposensis</i>	Dicot
Johnston's frankenia	<i>Frankenia johnstonii</i>	Dicot
Dwarf-flowered heartleaf	<i>Hexastylis naniflora</i>	Dicot
Slender rush-pea	<i>Hoffmannseggia tenella</i>	Dicot
Lyrate bladderpod	<i>Lesquerella lyrata</i>	Dicot

Walker's manioc	<i>Manihot walkerae</i>	Dicot
Mohr's Barbara button	<i>Marshallia mohrii</i>	Dicot
Texas trailing phlox	<i>Phlox nivalis ssp. texensis</i>	Dicot
Little Aguja (=Creek) Pondweed	<i>Potamogeton clystocarpus</i>	Monocot
Hinckley oak	<i>Quercus hinckleyi</i>	Dicot
Miccosukee gooseberry	<i>Ribes echinellum</i>	Dicot
Bunched arrowhead	<i>Sagittaria fasciculata</i>	Monocot
Green pitcher-plant	<i>Sarracenia oreophila</i>	Dicot
Fringed campion	<i>Silene polypetala</i>	Dicot
White-haired goldenrod	<i>Solidago albopilosa</i>	Dicot
Gentian pinkroot	<i>Spigelia gentianoides</i>	Dicot
Navasota ladies'-tresses	<i>Spiranthes parksii</i>	Monocot
Texas snowbells	<i>Styrax texanus</i>	Dicot
Cooley's meadowrue	<i>Thalictrum cooleyi</i>	Dicot
Persistent trillium	<i>Trillium persistens</i>	Monocot
Texas wild-rice	<i>Zizania texana</i>	Monocot
Large-fruited sand-verbena	<i>Abronia macrocarpa</i>	Dicot
Sensitive joint-vetch	<i>Aeschynomene virginica</i>	Dicot
Terlingua Creek cat's-eye	<i>Cryptantha crassipes</i>	Dicot
Smooth coneflower	<i>Echinacea laevigata</i>	Dicot
Chisos Mountain hedgehog Cactus	<i>Echinocereus chisoensis var. chisoensis</i>	Dicot
Schweinitz's sunflower	<i>Helianthus schweinitzii</i>	Dicot
Swamp pink	<i>Helonias bullata</i>	Monocot
Heller's blazingstar	<i>Liatris helleri</i>	Dicot
Rough-leaved loosestrife	<i>Lysimachia asperulaefolia</i>	Dicot
Michigan monkey-flower	<i>Mimulus michiganensis</i>	Dicot
Canby's dropwort	<i>Oxypolis canbyi</i>	Dicot
Michaux's sumac	<i>Rhus michauxii</i>	Dicot
Alabama canebrake pitcher-plant	<i>Sarracenia rubra alabamensis</i>	Dicot
Mountain sweet pitcher-plant	<i>Sarracenia rubra ssp. jonesii</i>	Dicot
Houghton's goldenrod	<i>Solidago houghtonii</i>	Dicot
Seabeach amaranth	<i>Amaranthus pumilus</i>	Dicot
White bladderpod	<i>Lesquerella pallida</i>	Dicot
Relict trillium	<i>Trillium reliquum</i>	Monocot
Texas prairie dawn-flower	<i>Hymenoxys texana</i>	Dicot
Alabama leather flower	<i>Clematis socialis</i>	Dicot
Mountain golden heather	<i>Hudsonia montana</i>	Dicot
Kral's water-plantain	<i>Sagittaria secundifolia</i>	Monocot
Texas ayenia	<i>Ayenia limitaris</i>	Dicot
Texas Golden Gladecress	<i>Leavenworthia texana</i>	Dicot
White irisette	<i>Sisyrinchium dichotomum</i>	Monocot
Golden sedge	<i>Carex lutea</i>	Monocot
Florida torreyia	<i>Torreya taxifolia</i>	Conf/cycds
Black spored quillwort	<i>Isoetes melanospora</i>	Ferns
Mat-forming quillwort	<i>Isoetes tegetiformans</i>	Ferns

Alabama streak-sorus fern	<i>Thelypteris pilosa</i> var. <i>alabamensis</i>	Ferns
False killer whale	<i>Pseudorca crassidens</i>	Mammal

Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Field –Accounting for Spray Drift Mitigation Labeling Restrictions.

The spray drift (in-field buffer) and rainfast mitigations discussed in the cotton section 3 ecological risk assessment (D404823), the concurrently issued soybean addendum (D426789) and at the beginning of this assessment are anticipated to restrict dicamba and DCSA residues above any threshold toxicity values to the agricultural field. Therefore, the following table describes the habitat and rationale for all listed species that were determined to not use cotton and soybean fields or resources that may overlap with dicamba DGA uses.

Species	Habitat	Rationale	Source
Animals			
<u>Alabama beach mouse</u> (<i>Peromyscus polionotus ammobates</i>)	Coastal sand dunes and coastal scrub (USFWS 1987, p. 2), (USFWS 2007, p. 4330); primary, secondary and interior or scrub dunes (USFWS 2009, p. 4, 11)	The proposed dicamba DGA uses are not expected to overlap with sand dunes of coastal scrub.	<p>USFWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/870812.pdf</p> <p>Federal Register. 2007. Department of the Interior, Fish and Wildlife Service. 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Alabama Beach Mouse. Vol. 72, No. 19. January 30, 2007. Available online at: http://www.gpo.gov/fdsys/pkg/FR-2007-01-30/pdf/07-270.pdf#page=1</p> <p>USFWS. 2009. Alabama beach mouse (<i>Peromyscus polionotus ammobates</i>, Bowen 1968), 5-Year Review: Summary and Evaluation. Daphne, Alabama. 34 pp. Available online at: http://ecos.fws.gov/docs/five_year_review/doc2996.pdf</p>

Species	Habitat	Rationale	Source
Alabama Red-belly turtle (<i>Pseudemys alabamensis</i>)	Streams, lakes and sloughs (USFWS, 1990, p. 1)	The proposed dicamba DGA uses are not expected to overlap with streams, lakes or sloughs.	USFWS. 1990. Recovery Plan for the Alabama Red-bellied Turtle. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/900108.pdf
<u>Austin blind salamander</u> (<i>Eurycea waterlooensis</i>)	Strictly aquatic and spend their entire lives submersed in water from the Barton Springs Segment of the Edwards Aquifer (Hillis et al. 2001, p. 273)(Page 51340) Rocky substrate, consisting of boulder, cobble, and gravel, with interstitial spaces that have minimal sediment (Page 51341)	The proposed dicamba DGA uses are not expected to overlap with water bodies.	USFWS 2013. <u>Designation of Critical Habitat for the Austin Blind and Jollyville Plateau Salamanders; Final Rule</u>
<u>Bachman's warbler</u> (<i>Vermivora bachmanii</i>)	Breeds in palustrine forested wetlands; seen near longleaf pine forest near brackish marsh. (USFWS 2007)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2007. Five Year Review: http://ecos.fws.gov/docs/five_year_review/doc1037.pdf
<u>Barton Springs salamander</u> (<i>Eurycea sosorum</i>)	Aquatic. Stenothermal spring flows, substrates are mixtures of gravel, cobble, aquatic plants, leaf litter and are free of sediment. Pools and spring runs, subsurface portions of the aquifer (within water-bearing karst formations). Found under boulder, cobble, gravel and plant (aquatic plants, leaf litter, woody debris) substrates. (USFWS 2005)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2005. Barton Springs salamander (<i>Eurycea sosorum</i>) recovery plan. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/050921.pdf .

Species	Habitat	Rationale	Source
<u>Bean</u> <u>Cumberland</u> <u>(pearlymussel)</u> <u>(<i>Villosa</i></u> <u><i>trabalis</i>)</u>	Restricted typically to tributary streams of the upper reaches of the Tennessee and Cumberland Rivers. This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, <i>V. trabalis</i> is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species (US FWS 2010, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc3244.pdf
Rayed Bean (<i>Villosa fabalis</i>)	Generally known from smaller, headwater creeks, but occurrence records exist from larger rivers. Usually found in or near shoal or riffle areas and in the shallow, wave-washed areas of glacial lakes.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Rayed Bean and Snuffbox Mussels Throughout Their Ranges. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
<u>Black-capped</u> <u>vireo (<i>Vireo</i></u> <u><i>atricapilla</i>)</u>	Insect-eating, migratory songbird. Arrive in Texas from mid-March to mid-April, while those in Oklahoma arrive approximately 10 days later. Breeding habitat is quite variable across its range, but is generally shrublands with a distinctive patchy structure. The shrub vegetation is mostly deciduous and generally extends from the ground to about six feet above ground and covers	The proposed dicamba DGA uses are not expected to overlap with shrublands associated with rocky gullies, edges of ravines, or eroded slopes.	USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1073.pdf USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910930h.pdf

Species	Habitat	Rationale	Source
	about 30 to 60% of the total area. Open grassland separates the clumps of shrubs. (US FWS 2007, p. 7) From Oklahoma through most of Texas, this type of vegetational configuration occurs most frequently on rocky substrates with shallow soils, in rocky gullies, on edges of ravines, and on eroded slopes. (US FWS 1991, p. 20)		
Butterfly, Kamer blue (<i>Lycaeides melissa samuelis</i>)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy (US FWS, 2003, pp.28-30)	The proposed dicamba DGA uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf
Butterfly, Mitchell's satyr (<i>Neonympha mitchellii mitchellii</i>)	Mitchell's satyr habitat is best characterized as a sedge-dominated fen community; Known habitats are all peatlands but range along a continuum from prairie/bog fen to sedge meadow/swamp. However, certain attributes at each site remain fairly constant. All historical and active habitats have a herbaceous community which is dominated by sedges, usually <i>Carex stricta</i> , with scattered deciduous and/or coniferous trees, most often <i>L. laricina</i> or <i>Juniperus virginiana</i> (red cedar) (US FWS 1998, pp. 11-12).	The proposed dicamba DGA uses are not expected to overlap with wetlands or areas with sedge communities.	USFWS 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf
Chub, spotfin (<i>Erimonax monachus</i>)	The species is an insectivore, feeding diurnally presumably by both sight and taste in benthic areas of slow to swift current over various substrates with little siltation.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/831121.pdf

Species	Habitat	Rationale	Source
	Streams may range from 15-60 m in width and, where occupied, 0.3-10.0 m in depth. Water temperature in their summer habitat usually reaches greater than 20°C, and submerged macrophytes are usually absent, occasionally common. The species has been observed associated with sand, gravel, rubble, boulder, and bedrock substrates (Jenkins and Burkhead, 1982) (US FWS 1983, p. 15).		
<u>Clubshell</u> (<i>Pleurobema clava</i>)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf
<u>Clubshell, ovate</u> (<i>Pleurobema perovatum</i>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 56)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Clubshell, southern</u> (<i>Pleurobema decisum</i>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 58)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Combshell, Cumberlandian</u> (<i>Epioblasma brevidens</i>)	This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse, sand, gravel, cobble, and boulders. It is not associated with small stream habitats and tends not to extend as far upstream in tributaries (US FWS 2004, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf

Species	Habitat	Rationale	Source
<u>Combshell</u> <u>southern</u> <u>(Epioblasma</u> <u>penita)</u>	This species inhabits the Tombigbee River, which is a major western tributary of the Mobile Basin. It is characterized by an increasing number of sand and gravel shoals and decreasing channel size (US FWS, 1989, p. 1)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Dace, blackside</u> <u>(Phoxinus</u> <u>cumberlandensi</u> <u>s)</u>	This species inhabits cool, small, upland streams with moderate flows. The fish is generally associated with undercut stream banks and large rocks, and it is usually found within well-vegetated watersheds with good riparian vegetation (US FWS 1988, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1988. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/880817.pdf
<u>Darter, amber</u> <u>(Percina</u> <u>antesella)</u>	This species inhabits gentle riffle areas over sand, gravel, and cobble substrates. Aquatic vegetation that develops in riffles provides habitat for feeding and cover (US FWS, 1986, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf
<u>Darter, boulder</u> <u>(Etheostoma</u> <u>wapiti)</u>	This species inhabits warm-water riverine environments and has been found only in moderate to fast current over boulder/slab rock substrate in water over 2 feet deep (US FWS, 1989, p. 2).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890727.pdf
<u>Darter,</u> <u>Cumberland</u> <u>(Etheostoma</u> <u>susanae)</u>	This species inhabits pools or shallow runs of low to moderate gradient sections of streams with stable sand, silt, or sand-covered bedrock substrates (US FWS, 2012, p. 63605).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Designated Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>Darter,</u> <u>duskytail</u> <u>(Etheostoma</u> <u>percnurum)</u>	This species inhabits rocky areas in gently flowing shallow pools and runs in large creeks and moderately large rivers in the Tennessee and Cumberland River Systems (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/duskytaildarter_RP.pdf

Species	Habitat	Rationale	Source
<u>Darter, slackwater</u> (<i>Etheostoma boschungii</i>)	Nonbreeding habitat is small to moderately large streams. The current is usually slow, and under normal conditions, the flow ranges from still to 0.34 m/sec. In small streams, the darters show no position preference; however, in large streams they seem to confine themselves to near the banks or to undercuts in the banks. They also occur on gravel infiltrated with silt, on silt and mud, or in a combination of these. The breeding habitat is seepage water in open fields and woods (US FWS, 1984, pp. 7-8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840308.pdf
<u>Darter, snail</u> (<i>Percina tanasi</i>)	This species occupies seven of nine tributaries of the upper Tennessee River in Alabama, Georgia and Tennessee (US FWS, 2013, p. 10).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4136.pdf
<u>Dragonfly, Hine's emerald</u> (<i>Somatochlora hineana</i>)	The Hine's emerald dragonfly occupies grass marshes and sedge meadows fed primarily by water from a mineral source or fens. Two important characteristics of the habitat appear to be groundwater-fed, shallow water slowly flowing through vegetation, and underlying dolomitic or limestone bedrock. Parts of the aquatic channels are typically covered by vegetation such as cattails or sedges. Soils can range from organic muck to mineral soils like marl. Two other important components are areas of open vegetation for foraging and forests, trees or shrubs that provide shaded areas for perching or roosting. Nearby adjacent	The proposed dicamba DGA uses are not expected to overlap with grass marshes, sedge meadows, forested areas, or other habitat where the Hine's emerald dragonfly is expected to be found.	USFWS. 2001. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/010927.pdf

Species	Habitat	Rationale	Source
	<p>forests may be deciduous (Illinois) or conifer (Wisconsin and Michigan).</p> <p>Larvae are usually found in small flowing streamlets within cattail marshes, sedge meadows, and hummocks. Places with silt, leaf litter, and decaying grasses as a substrate are often used (US FWS, 2001, p. 15-16.).</p> <p>Critical Habitat of 26,531 acres have been designated in Michigan, Illinois, Wisconsin, and Missouri. Almost half of this is Mackinac County, MI.</p>		
<u>Elktoe, Appalachian</u> <u>(<i>Alasmidonta raveneliana</i>)</u>	This species has been reported from relatively shallow medium-sized creeks and rivers with cool, well-oxygenated, and moderate-to fast-flowing water. It has been observed in gravelly substrata, often mixed with cobble and boulders; in cracks in bedrock; and occasionally in relatively silt-free, coarse, sandy substrata (US FWS, 1996, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960826.pdf
<u>False killer whale</u> <u>(<i>Pseudorca crassidens</i>)</u>	Deep water: "They prefer tropical to temperate waters that are deeper than 3,300 feet (1000 m)."	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/falsekillerwhale.htm
<u>Fanshell</u> <u>(<i>Cyprogenia stegaria</i>)</u>	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf

Species	Habitat	Rationale	Source
<u>Flattened musk turtle</u> (<i>Sternotherus depressus</i>)	Streams, Lake margins (USFWS 1990, p 3); spend most of their time in benthic habitats (USFWS 1990, p 5) Optimum habitat includes creeks and small rivers with vegetated areas with depth of 3 - 600 cm (USFWS 1990, p 3)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks or other water bodies.	USFWS. 1990. Recovery Plan for the Flattened Musk Turtle. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/900226.pdf
<u>Frosted Flatwoods salamander</u> (<i>Ambystoma cingulatum</i>)	Fire-maintained, open-canopied, flatwoods and savannas dominated by longleaf pine (<i>Pinus palustris</i>), with naturally occurring slash pine (<i>P. elliotti</i>) in wetter areas. Adults spend most of their lives underground. Breed in small, isolated ephemeral ponds (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with flatwoods or savannas.	USFWS 2009. Federal Register, vol. 74, No. 62. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
<u>Georgetown salamander</u> (<i>Eurycea nanafragia</i>)	Aquatic. The Northern Segment of the Edwards Aquifer, which is a karst aquifer characterized by open chambers such as caves, fractures, and other cavities that were formed either directly or indirectly by dissolution of subsurface rock formations. (USFWS 2014, Pg. 10237)	The proposed dicamba DGA uses are not expected to overlap with cave aquifers.	USFWS 2014. <u>Determination of Threatened Species Status for the Georgetown Salamander and Salado Salamander Throughout Their Ranges. Final Rule</u>
<u>Golden-cheeked warbler</u> (<i>Dendroica chrysoparia</i>)	Forest (USFWS 1992, p. 7)	The proposed dicamba DGA uses are not expected to overlap with forest.	USFWS 1992. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/920930f.pdf
<u>Heelsplitter, Alabama (=inflated)</u> (<i>Potamilus inflatus</i>)	This species prefers a soft, stable substrate in slow to moderate currents. It has been found in sand, mud, silt and sandy-gravel, but not in large or armored gravel (US FWS, 1993, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930413.pdf

Species	Habitat	Rationale	Source
<u>Jollyville Plateau salamander</u> (<i>Eurycea tonkawae</i>)	Jollyville Plateau salamanders are strictly aquatic and spend their entire lives submersed in water sourced from the Northern Segment of the Edwards Aquifer, the Trinity Aquifer, and local alluvium (loose unconsolidated soils) (COA 2001, pp. 3–4; Bowles et al. 2006, p. 112; Johns 2011, p. 5–6). (Page 51340) Rocky substrate, consisting of boulder, cobble, and gravel, with interstitial spaces that have minimal sediment (Page 51341)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks or other water bodies.	USFWS 2013. <u>Designation of Critical Habitat for the Austin Blind and Jollyville Plateau Salamanders: Final Rule</u>
<u>Kidneyshell, fluted</u> (<i>Ptychobranchius subtentum</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
<u>Kidneyshell, triangular</u> (<i>Ptychobranchius greenii</i>)	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 60)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf
<u>Lampmussel, Alabama</u> (<i>Lampsilis virescens</i>)	This species inhabits sand and gravel substrates in small to medium sized streams (US FWS, 1985, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/850702.pdf

Species	Habitat	Rationale	Source
<u>Lilliput, pale (pearly mussel) (<i>Toxolasma cylindrellus</i>)</u>	This species is observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840822.pdf
<u>Loggerhead sea turtle (<i>Caretta caretta</i>)</u>	Ocean, Beaches, Neritic zone (NMFS 2009, p I-20)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS and USFWS. 2009. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle, Second Revision. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/090116.pdf
<u>Logperch, Conasauga (<i>Percina jenikins</i>)</u>	This species has been collected in deep shuts and flowing pools with clear, clean gravel and mixed rubble substrates in areas with moderate to swift currents (US FWS, 1986, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/860620.pdf
<u>Lynx, Canada (<i>Lynx canadensis</i>)</u>	PCE: Boreal forest landscapes with large populations of snowshoe hares. Distribution and abundance of prey and microclimate influence movement, hunting behavior, and den and resting site locations. Areas with dense cover.	The proposed dicamba DGA uses are not expected to overlap with boreal forests. The lynx's prey, snowshoe hares, also do not overlap with the proposed dicamba DGA use sites.	USFWS. 2014. Federal Register Notice: Designation of Critical Habitat http://www.gpo.gov/fdsys/pkg/FR-2014-09-12/pdf/2014-21013.pdf
<u>Manatee, West Indian (<i>Trichechus manatus</i>)</u>	This species lives in freshwater, brackish and marine habitats (US FWS, 2001, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2001. Recovery Plan- Third Revision. http://ecos.fws.gov/docs/recovery_plan/011030.pdf

Species	Habitat	Rationale	Source
Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)	The Mexican long-nosed bat has evolved an apparent mutualistic association with <i>Agave sp.</i> The bat is principally a nectar feeder, foraging on the flowers of <i>Agave</i> , and in some minor proportions consuming the pollen, fruits, and any incidental insects associated with the flowers. The bats occupy mid- to high-elevation desert scrub, open conifer-oak woodlands, and pine forest habitats in the Upper Sonoran and Transition Life Zones.	The proposed dicamba DGA uses are not expected to overlap with the desert scrub, open conifer-oak woodlands and pine forest habitats of the bat. The bat's major resource need, <i>Agave</i> plants are not expected to be on soybean and cotton fields.	USFWS. 1994. Recovery Plan. https://ecos.fws.gov/docs/recovery_plan/940908.pdf
Mexican spotted owl (<i>Strix occidentalis lucida</i>)	Forest and canyonlands in SW U.S. (USFWS 2011, p. 7).	The proposed dicamba DGA uses are not expected to overlap with forests or Canyonlands.	USFWS 2011. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/FR00000557-%20BP031995%20Draft%20MSO%20Recovery%20Plan%20First%20Revision.pdf
Moccasinshell, Alabama (<i>Medionidus acutissimus</i>)	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 51)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
Moccasinshell, Coosa (<i>Medionidus parvulus</i>)	Inhabits sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. (US FWS 2000, p. 52)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
Monkeyface, Cumberland (pearly mussel) (<i>Quadrula intermedia</i>)	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709b.pdf

Species	Habitat	Rationale	Source
	and shoal areas (US FWS, 1984, p. 9).		
<u>Mucket, orangenacre</u> <u>(<i>Lampsilis perovalis</i>)</u>	Currently restricted to high quality stream and small river habitat, the species is found on stable sand/gravel/cobble substrate in moderate to swift currents (US FWS 2000, p. 55)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Mucket, pink (pearly mussel)</u> <u>(<i>Lampsilis abrupta</i>)</u>	<p>The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10).</p> <p>The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the water is flowing (US FWS, 1985, p. 10).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf
<u>Mussel, oyster</u> <u>(<i>Epioblasma capsaeformis</i>)</u>	This species is generally adapted to live in the gravel shoals of free-flowing rivers and streams (US FWS, 2004, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
<u>Mussel, sheepnose</u> <u>(<i>Plethobasus cyphus</i>)</u>	The sheepnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf

Species	Habitat	Rationale	Source
	boulders. Sheepnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).		
<u>Mussel snuffbox</u> <u>(<i>Epioblasma triquetra</i>)</u>	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Federal Register Notice: Listing. http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27413.pdf#page=2 USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
<u>North Atlantic Right Whale</u> <u>(<i>Eubalaena glacialis</i>)</u>	The North Atlantic right whale primarily occurs in coastal or shelf waters, but may go into deeper waters. (NMFS 2004, p. v)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS. 2004. Recovery plan for the north Atlantic right whale (<i>Eubalaena glacialis</i>). Available online at: http://ecos.fws.gov/docs/recovery_plan/whale_right_northatlantic.pdf
<u>Northern aplomado falcon</u> (<i>Falco femoralis septentrionalis</i>)	Open terrain with scattered trees or shrubs. Found along yacca covered sand ridges in coastal prairies Riparian woodlands in open grasslands Desert grasslands (USFWS 1990, p. 13).	Recommend off-field status for row crop agriculture. According to the Aplomado Recovery Plan (USFWS 1990), suitable habitat contains of terrain with inter-tree distances of 15 to 45 m with a mean of 30 m and a woody plant density of 0.48 tree/ha. The suitable land covers include yucca-covered ridges of coastal prairies,	USFWS 1990. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/900608.pdf

Species	Habitat	Rationale	Source
		grasslands, prairies, desert grasslands, and riparian wooded areas near open grasslands. While the recovery plan is not specific as to row crop usage by the species, additional information on monitored individual falcons in Texas indicated that the only agricultural association with foraging falcons is for grazing lands and for fallow agricultural fields. (Perez et al. 1996)	
<u>Pearlymussel, dromedary</u> (<i>Dromus dromas</i>)	This species is most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
<u>Pearlymussel, littlewing</u> (<i>Pegias fabula</i>)	This species inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins (US FWS, 1989, p. 5).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890922.pdf
<u>Pearlymussel, Slabside</u> (<i>Pleurotaia dolabelloides</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf

Species	Habitat	Rationale	Source
	finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)		
<u>Perdido Key beach mouse</u> (<i>Peromyscus polionotus trissyllepsis</i>)	Coastal sand dunes & coastal scrub (USFWS 1987, p. 2); primary, secondary and interior or scrub dunes (USFWS 2007, p. 9)	The proposed dicamba DGA uses are not expected to overlap with sand dunes or coastal scrub.	USFWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/870812.pdf . USFWS. 2007. Perdido Key Beach Mouse (<i>Peromyscus polionotus trissyllepsis</i>), 5-Year Review: Summary and Evaluation. Panama City, Florida. 24 pp. Available online at: http://ecos.fws.gov/docs/five_year_review/doc1081.pdf .
<u>Pigtoe, finerayed</u> (<i>Fusconaia cuneolus</i>)	This species is typically a riffle species that inhabits ford and shoal areas in free-flowing streams of moderate gradient (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/fine%20rayed%20recov%20plan.pdf
<u>Pigtoe, Georgia</u> (<i>Pleurobema hanleyianum</i>)	This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. It also requires a host fish, which is currently unknown (US FWS, 2013, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Draft Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Hartfield%20and%20Powell%202013%20Draft%20Three%20Mollusks%20RP%20062813.pdf
<u>Pigtoe, rough</u> (<i>Pleurobema plenum</i>)	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and in sand and gravel substrates (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf

Species	Habitat	Rationale	Source
<u>Pigtoe, shiny</u> <u>Entire</u> <u>(Fusconaia cor)</u>	This species is typically a riffle species, found along fords and shoals of clear, moderate to fast-flowing streams and rivers with stable substrate. It does not inhabit deep pools or impounded areas. This species is usually found well-buried in the substrate during most of the year and is more readily visible in early summer (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709d.pdf
<u>Pigtoe, southern</u> <u>(Pleurobema</u> <u>georgianum)</u>	Sand/gravel shoals and runs of small rivers and large streams (US FWS 2000, p. 59)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2000. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/001117.pdf
<u>Pimpleback,</u> <u>orangefoot</u> <u>(pearlymussel)</u> <u>(Plethobasus</u> <u>cooperianus)</u>	The 1984 Recovery Plan indicated that the orange-foot pimpleback was known from the Tennessee, Cumberland, and lower Ohio Rivers (US FWS, 1984, p. 2). The habitat is described as medium to large rivers in sand and gravel substrates. In the Ohio River it was collected from 15-29 feet depths, but may have lived in shallower riffles (US FWS, 1984, p. 6).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840930b.pdf
<u>Plover, piping</u> <u>except Great</u> <u>Lakes</u> <u>watershed</u> <u>(Charadrius</u> <u>melodus)</u>	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation. At inland lakes, they use barren	The proposed dicamba DGA uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf

Species	Habitat	Rationale	Source
	to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).		
<u>Pocketbook, fat</u> <u>(Potamilus</u> <u>capax)</u>	The fat pocketbook is a large river species requiring flowing water and a stable substrate, which can vary widely but is most likely a mixture of sand, silt and clay. It occurs in water from a few inches deep to at least 8 feet. Habitat includes drainage ditches. (US FWS, 1989, p. 6). Populations have been found in larger rivers in the Ohio River system, and it may occur as deep as 20 feet (US FWS, 2012, p. 7-8). It can also tolerate periods of high suspended sediments (US FWS, 2012, p. 11).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/891114c.pdf
<u>Pocketbook,</u> <u>finelined</u> <u>(Lampsilis</u> <u>atilis)</u>	Live embedded in the bottom sand, gravel, and/or cobble substrates of rivers and streams (US FWS 2004, p. 40097).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks or other water bodies.	USFWS. 2004. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2004-07-01/pdf/04-14279.pdf#page=1
<u>Purple Cat's</u> <u>paw (=Purple</u> <u>Cat's paw</u> <u>pearlymussel)</u> <u>(Epioblasma</u> <u>obliquata</u> <u>obliquata)</u>	Inhabits boulder to sandy substrates in large rivers of the Ohio River basin (US FWS 1992, Executive summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920310.pdf
<u>Rabbitsfoot</u> <u>(Quadrula</u> <u>cylindrica</u> <u>cylindrica)</u>	"Rabbits foot is primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity." They have been reported in deep water runs up to 12 feet depth.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf

Species	Habitat	Rationale	Source
	"Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).		
<u>Red Hills salamander</u> (<i>Phaeognathus hubrichti</i>)	Mesic ravine slopes and bluff sides (facing North) with hardwood trees. Burrows within siltstone. Usually found on sites with loamy, friable topsoils (USFWS 1983)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery plan for the red hills salamander (<i>Phaeognathus hubrichti</i> Highton). United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/831123.pdf
<u>Reticulated flatwoods salamander</u> (<i>Ambystoma bishopi</i>)	Aquatic and terrestrial. Longleaf pine ecosystems (Coastal Plain in what were historically longleaf pine-wiregrass flatwoods and savannas). Adults spend most of their lives underground. Breed in small, isolated ephemeral ponds. (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2009. Federal Register, vol. 74, No. 26. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
<u>Riffleshell, northern</u> (<i>Epioblasma torulosa rangiana</i>)	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf

Species	Habitat	Rationale	Source
<u>Riversnail, Anthony's (<i>Athearnia anthonyi</i>)</u>	This species is typically found in large streams on large submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water (US FWS, 1997).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970813.pdf
<u>Roseate tern (<i>Sterna dougallii dougallii</i>)</u>	Rocky offshore islands with sparse vegetation; although Northeastern Roseate tern nest under vegetation or some other shelter (USFWS 1993, p. 3).	The proposed dicamba DGA uses are not expected to overlap with offshore islands.	USFWS 1993. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/930924_v2.pdf
<u>Salado salamander (<i>Eurycea chisholmensis</i>)</u>	Aquatic. The Northern Segment of the Edwards Aquifer, which is a karst aquifer characterized by open chambers such as caves, fractures, and other cavities that were formed either directly or indirectly by dissolution of subsurface rock formations. (USFWS 2014, Pg. 10237)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2014. <u>Determination of Threatened Species Status for the Georgetown Salamander and Salado Salamander Throughout Their Ranges</u> . Final Rule
<u>San Marcos salamander (<i>Eurycea nana</i>)</u>	Aquatic Spring Lake. Found among aquatic plants on the bottom of the lake. Found under stones in sand and gravel areas. Must have flowing water (from springs flowing into Spring Lake). (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1996. San Marcos and Comal Springs and associated aquatic ecosystems (Revised) recovery plan. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery_plan/960214.pdf
<u>Sea turtle, green (<i>Chelonia mydas</i>)</u>	Green turtles are primarily restricted to tropical and subtropical waters. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found from Massachusetts to Texas and in the U.S. Virgin Islands and Puerto Rico...Seagrasses are the principal dietary	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

Species	Habitat	Rationale	Source
	component of juvenile and adult green turtles throughout the Wider Caribbean region (Bjorndal, 1995). (NMFS, NOAA 1998, p. 46694)		
<u>Sea turtle, hawksbill</u> <u>(<i>Eretmochelys imbricata</i>)</u>	The hawksbill turtle occurs in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Coral reefs, like those found in the waters surrounding Mona and Monito Islands, are widely recognized as the primary foraging habitat of juvenile, subadult, and adult hawksbill turtles. This habitat association is directly related to the species' highly specific diet of sponges (Meylan, 1988). Hawksbills depend on coral reefs for food and shelter; therefore, the condition of reefs directly affects the hawksbill's well-being. (NMFS, NOAA 1998, p. 46695)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf
<u>Sea turtle, Kemp's ridley</u> <u>(<i>Lepidochelys kempii</i>)</u>	This life history pattern is characterized by three basic ecosystem zones: (1) Terrestrial zone (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) Neritic zone - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2011, p. I-8)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2011. Bi-national recovery plan for the kemp's ridley sea turtle. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

Species	Habitat	Rationale	Source
<u>Sea turtle leatherback</u> <u>(<i>Dermochelys coriacea</i>)</u>	Leatherbacks are able to take advantage of a wide variety of marine ecosystems (reviewed by Saba 2013; see NOAA large marine ecosystem website: http://www.lme.noaa.gov/). Within these ecosystems, various oceanic features such as water temperature, downwelling, Ekman upwelling, sea surface height, chlorophyll-a concentration, and mesoscale eddies affect the presence of leatherbacks (Bailey et al. 2013; Benson et al. 2011). The physical characteristics observed within these marine ecosystems also affect the distribution and abundance of leatherback prey (reviewed by Saba 2013). (NMFS, NOAA 2013, p. 20-22).	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2013. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/090116.pdf
<u>Shiner, Arkansas River</u> <u>(<i>Notropis girardi</i>)</u>	Wilde et al. (2000) found no obvious selection for or avoidance of any particular habitat type (i.e., main channel, side channel, backwaters, and pools) by Arkansas River shiner. Arkansas River shiners did tend to select side channels and backwaters slightly more than expected based on the availability of these habitats (Wilde et al. 2000). Likewise, they appeared to make no obvious selection for, or avoidance of, any particular substrate type. Substrates (i.e., the river bed) in the Canadian River in New Mexico and Texas were predominantly sand, however, the Arkansas River shiner was observed to occur over silt slightly more than	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2005. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/recovery_plan/950830.pdf

Species	Habitat	Rationale	Source
	<p>expected based on the availability of this substrate (Wilde et al. 2000) ; preferred habitat for the Arkansas River shiner is the mainstem of larger plains rivers... historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin (Gilbert 1980). Adults are uncommon in quiet pools or backwaters lacking streamflow, and almost never occurred in habitats having deep water and bottoms of mud or stone (Cross 1967) (US FWS 2005).</p>		
<p><u>Shiner, blue</u> <u>(<i>Cyprinella</i></u> <u><i>caerulea</i>)</u></p>	<p>The blue shiner primarily occupies second to fourth order, moderate gradient streams within the Ridge and Valley and Piedmont physiographic provinces of Alabama, Georgia, and Tennessee (Smith-Vaniz 1968, Ramsey 1976, Krotzer 1984, Ramsey and Pierson 1986, Pierson and Krotzer 1987, Mayden 1989, Pierson et al. 1989, Boschung 1992, Etnier and Starnes 1993, Dobson 1994). Most watersheds where it is found are predominately forested, and agriculture and urban development are minimal. For example in Alabama, land cover in the Choccolocco watershed is 66 percent forest, 20 percent pasture, and 13 percent agriculture...It prefers a sand or sand and gravel substrate sometimes with cobble, low to moderate velocity current, and a depth of about 0.15 to 1 meters (0.5 to 3 feet)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>US FWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950830.pdf</p>

Species	Habitat	Rationale	Source
	(Gilbert et al. 1979; Krotzer 1984, Pierson and Krotzer 1987, Dobson 1994) (US FWS 1995, p. 3-4)		
<u>Shiner, smalleye</u> (<u>Notropis buccula</u>)	Occur in fairly shallow, flowing water, often less than 0.5 m deep with sandy substrates (US FWS 2014, p. 45252)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2014-08-04/pdf/2014-17694.pdf
<u>Snake, copperbelly water</u> (<u>Nerodia erythrogaster neglecta</u>)	Copperbellies are generally affiliated with wetlands and prefer shallow wetlands, such as shrub-scrub wetlands dominated by buttonbush (<i>Cephalanthus occidentalis</i>), emergent wetlands, or the margins of palustrine open water wetlands. Buttonbrush swamps are used as basking areas. Areas frequented by copperbellies generally have an open canopy, shallow water, and short dense vegetation. Uplands are also important. (US FWS, 2008, p. 17-18). Critical Habitat has not been designated for the snake because of concerns related to illegal collection (US FWS, 2008, p. 20).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2008. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/081223.pdf
<u>Spectaclecase (mussel)</u> (<u>Cumberlandia monodonta</u>)	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf

Species	Habitat	Rationale	Source
	found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).		
<u>Spider, spruce-fir moss</u> <i>(Microhexura montivaga)</i>	Typical habitat appears to be associated with moist, well-drained moss mats growing on rocks and boulders in well-shaded situations in mature high-elevation conifer forests dominated by Fraser fir, <i>Abies fraseri</i> , often with scattered red spruce, <i>Picea rubens</i> . (US FWS 1998, p. iii)	The proposed dicamba DGA uses are not expected to overlap with high-elevation conifer forests.	USFWS, 1998, Recovery Plan. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
<u>Southwestern willow flycatcher</u> <i>(Empidonax traillii extimus)</i>	Breeding: Forested wetlands or scrub-shrub wetlands-dense riparian habitat of rivers, swamps, wetlands, lakes (USFWS 2002, p. iv). Wintering: brushy savanna edges, second growth, shrubby clearings and pastures, woodlands near water (USFWS 2002, p. iv).	Recommend off-field status for row crop agriculture. According to the Critical Habitat designation document (USFWS 2013) essential characteristics for southwestern will flycatcher habit include riparian areas for flowing stream that support expansive riparian vegetation areas. Riparian trees and understory species are viewed as essential elements of flycatcher habitat. Row crop soy and corn are monocultures of non-riparian vegetation and consequently not suitable habitat for this species.	USFWS 2002. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plans/2002/020830c.pdf USFWS. 2013. Designation of Southwestern Willow Flycatcher Critical Habitat: Final Rule. Federal Register Vol. 78 No.2.

Species	Habitat	Rationale	Source
<u>Sperm whale</u> (<i>Physeter catodon</i> (= <i>macrocephalus</i>))	Ocean/ Water depth of 1968 feet or more (NMFS 2012)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS. 2012. Sperm whales (<i>Physeter catodon</i>). National Marine Fisheries Service. Available online at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm
<u>Squirrel, Carolina northern flying</u> (<i>Glaucomys sabrinus coloratus</i>)	Species composition of the occupied forest may vary in different locations, some combination of hardwoods and conifers (particularly spruce and fir) appears essential to support these animals...Food sources for the Carolina northern flying squirrel include fungi, lichens, staminate cones, insects, and other animal matter (US FWS 1990, p. 6-7)	The proposed dicamba DGA uses are not expected to overlap with hardwood and conifer forests.	USFWS. 1990. Recovery Plan for Appalachian Northern Flying Squirrels. United States Fish and Wildlife Service.
<u>Stirrupshell</u> (<i>Quadrula stapes</i>)	Habitat is the Tombigbee River, characterized by an increasing number of sand and gravel shoals and decreasing channel size in the upper portions (US FWS, 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/891114e.pdf
<u>Sturgeon, gulf</u> (<i>Acipenser oxyrinchus desotoi</i>)	The Gulf sturgeon is an Anadromous fish which migrates from salt water into large coastal rivers to spawn and spend the warm months. The majority of its life is spent in fresh water (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950922.pdf
<u>Sturgeon, pallid</u> (<i>Scaphirhynchus albus</i>)	Habitat is the bottom in swift waters of large, turbid, free-flowing rivers, often over sand substrates, but other substrates include at least gravel and rock. Sloughs, chutes, and side channels that transition from floodplain to the main channels are apparently important as spawning, nursery, and feeding areas.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Pallid%20Sturgeon%20Recovery%20Plan%20First%20Revision%20signed%20version%20012914_3.pdf USFWS. 2007. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc1059.pdf

Species	Habitat	Rationale	Source
	Within the subject states, this habitat occurs in the Mississippi and Missouri rivers (US FWS, 1993, pp 6-7). Within this habitat, they tend to select main channel habitats in the Mississippi River, and main channel habitats with islands or sand bars in the upper Missouri River (US FWS, 2007, p. 8). They do not typically occur in impounded areas due to lower flows and other hydrologic factors, nor where channel stabilization has reduced channel meandering and access to floodplain areas (US FWS, 2007, p. 38).		
<u>Tem. least interior pop. (<i>Sterna antillarum</i>)</u>	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting occurs along river banks (US FWS, 1990, p. 20).	The proposed dicamba DGA uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf
<u>Texas blind salamander (<i>Typhlomolge rathbuni</i>)</u>	Aquatic, subterranean (caves) (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1996. San Marcos and Comal Springs and associated aquatic ecosystems (Revised) recovery plan. United States Fish and Wildlife Service. Available online at:

Species	Habitat	Rationale	Source
			http://ecos.fws.gov/docs/recovery_plan/960214.pdf
Warbler, Kirtland's (<i>Setophaga kirtlandii</i>)	<p>Forests (US FWS 1985, p. 8)</p> <p>During breeding, Kirtland's warblers are located in Michigan. Its wintering grounds are located in the Bahamas, where it spends 8 months of the year (September-April). (US FWS 1985)</p> <p>In migration, the bird travels a fairly direct route between its nesting and wintering ranges, entering and leaving the continent at the coast of North and South Carolina (USFWS 1985, p. 5).</p> <p>With one or few exceptions, all nests have been found on Grayling sand soil (USFWS 1985, p. 7).</p>	The proposed dicamba DGA uses are not expected to overlap with forests.	<p>USFWS. 1985 Kirtland's Warbler Recovery Plan. Updated.</p> <p>http://ecos.fws.gov/docs/recovery_plan/850930.pdf</p>
Whale, finback (<i>Balaenoptera physalus</i>)	Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally.	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm
Whale, humpback (<i>Megaptera novaeangliae</i>)	<p>During migration, humpbacks stay near the surface of the ocean.</p> <p>While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found</p>	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm

Species	Habitat	Rationale	Source
	<p>in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.</p> <p>Humpback feeding grounds are in cold, productive coastal waters.</p>		
<u>Wartyback,</u> <u>white</u> <u>(pearlymussel)</u> <u>(<i>Plethobasus</i></u> <u><i>cicatricosus</i>)</u>	<p>The white wartyback has undergone a substantial range reduction and is considered to be possibly extinct. It was historically distributed in the Wabash, Ohio, Kanawha, Cumberland, Holston, and Tennessee Rivers of the Ohio, Cumberland, and Tennessee River systems; however, no live specimens have been recovered from these drainages since the early 1900s). The white wartyback may still exist in a short reach of the Tennessee River below Pickwick Dam. No living populations have been found in numerous surveys conducted in the Tennessee River since the 1960s; however, fresh dead specimens were collected in 1979 and 1982 below Pickwick Dam near Savannah, Tennessee. If this species still exists, the viability of remaining populations is extremely threatened</p> <p>The white wartyback is a riffle species that is typically found in large rivers in gravel substrates.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with coastal waters.</p>	<p>USFWS, 1984, Recovery Plan White Warty-backed Pearlymussel http://ecos.fws.gov/docs/recovery_plan/060313h.pdf http://ecos.fws.gov/docs/life_histories/F00M.html</p>

Species	Habitat	Rationale	Source
<u>Woodpecker</u> <u>red-cockaded</u> <u>Entire (<i>Picoides</i></u> <u><i>borealis</i>)</u>	Habitat: Forest, Savannah (open pine woodlands and savannahs with large old pines) (US FWS 2003, p. x) Habitat size (home range): 116 – 357 acres (US FWS 2003, p. 49)	Proposed dicamba DGA uses are not expected to overlap with forest or savannah.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf
Wood stork (<i>Mycteria americana</i>)	Freshwater and estuarine Wetlands. (US FWS 1986, p. iii). Wood storks breed in FL, GA and SC. They migrate south in winter (US FWS 1986, p. 2). Require a mosaic of wetlands with varying climatological and seasonal conditions around colonies and within the wintering habitat in the coastal plain of the Southeast U.S. (US FWS 2006, p. 12).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970127.pdf USFWS. 2006. Five year Review. http://ecos.fws.gov/docs/five_year_review/doc1115.pdf
<u>Noonday globe</u> (<i>Patera clarki nantahala</i>)	Found mainly on the southeast side of the Nantahala River Gorge. Area is strikingly different than the surrounding area, very steep, with a mix of various hardwood trees and hemlock, and has a rich herbaceous undergrowth. The area is interrupted frequently by small streams, waterfalls, seeps, springs, and often shaded. The forest floor has a thick humus layer with much exposed rock, where the snail is most abundant on and around moist rock outcrops, but also found in thick leaf litter and humus layers around	The proposed dicamba DGA uses are not expected to overlap with forests.	Noonday Globe <i>Patera</i> (= <i>Mesodon</i>) <i>clarki nantahala</i> 5-Year Review: Summary and Evaluation, Page 4 Available at: http://ecos.fws.gov/docs/five_year_review/doc4295.pdf

	the base of ferns and underneath rhododendron and dog hobbe, and other moist habitats. Moisture is key.		
<u>Phantom springsnail</u> (<i>Pyrgulopsis texana</i>)	<p>The Phantom springsnail occurs only in the four remaining desert spring outflow channels associated with the San Solomon Spring system (San Solomon, Phantom, Giffin, and East Sandia springs).</p> <p>Habitat of the species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41). They are also commonly found attached to plants, particularly in dense stands of submerged vegetation (Chara sp.). Field and laboratory experiments have suggested Phantom springsnails prefer substrates harder and larger in size (Bradstreet 2011, p. 91).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41236. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf</p>
<u>Phantom tryonia</u> (<i>Tryonia cheatumi</i>)	The Phantom tryonia occurs only in the four remaining desert spring outflow channels associated with the San	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41236-41237. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf</p>

	<p>Solomon Spring system (San Solomon, Phantom, Giffin, and East Sandia springs) (Taylor 1987, p. 40; Allan 2011, p. 1; Lang 2011, entire).</p> <p>The species is found on both soft and firm substrates on the margins of spring outflows (Taylor 1987, p. 41), and they are also commonly found attached to plants, particularly in dense stands of submerged vegetation (<i>Chara</i> sp.).</p>		
<u>Armored snail (<i>Pyrgulopsis</i> (= <i>Marstonia</i>) <i>pachyta</i>)</u>	<p>The armored snail is currently only known from Limestone and Piney Creeks, Limestone County, Alabama, and appears to be most abundant in submerged root masses and bryophytes (non-vascular land plants, e.g. mosses) along the creek edges, but also may occur on rocks and leafy/woody debris, and on other aquatic macrophytes (aquatic plants) (Garner 2004a, Haggerty and Garner 2007, 2008).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2010. Armored Snail (<i>Marstonia pachyta</i>) 5-Year Review. Page 2. Available at: http://ecos.fws.gov/docs/five_year_review/doc3288.pdf</p>
<u>Pecos assiminea snail (<i>Assiminea</i> <i>pecos</i>)</u>	<p>The Pecos assiminea requires saturated, moist soil at stream or spring-run margins and is found in wet mud or beneath mats of vegetation, usually within 1 inch (in) (2 to 3 centimeters (cm)) of flowing water. Spring complexes that</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2011. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule. Page 33039. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf</p>

	<p>contain flowing water create saturated soils that provide the specific habitat needed for population growth, sheltering, and normal behavior of the species. Although this snail seldom occurs immersed in water, the species cannot withstand permanent drying of springs or spring complexes. Consequently, wetland plant species are required to provide leaf litter (dead leaf material), shade, and appropriate microhabitat. Plant species such as <i>Scirpus americanus</i> (American three-square), <i>Eleocharis spp.</i> (spike rush), <i>Distichlis spicata</i> (inland saltgrass), and <i>Juncus spp.</i> (rushes) provide the appropriate cover and shelter required by Pecos assiminea (NMDGF 2005, p. 13).</p>		
<p><u>Diamond Y Spring snail</u> (<u><i>Pseudotryonia adamantina</i></u>)</p>	<p>Habitat of the species is primarily soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush (<i>Scirpus americanus</i>) and saltgrass (<i>Distichlis spicata</i>) (Taylor 1987, p. 38; Echelle et al. 2001, p.5).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41237. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf</p>

<u>Tulotoma snail</u> (<u>Tulotoma</u> <u>magnifica</u>)	Tulotoma occur in cool, well-oxygenated, clean, free-flowing streams, including rivers and the lower portions of the rivers' larger tributaries (Herschler et al. 1990, p. 822). This species is generally found in shoals (a shallow place in a body of water) and riffles (a rocky shoal lying just below the surface of the water) with moderate to strong currents. Although this species is typically associated with shoals and riffles, it inhabits rivers that rise and fall, and tulotoma have been collected at depths more than 5 meters (m) (15 feet (ft)) (Hartfield 1991, p. 7). The species is strongly associated with boulder, cobble, and bedrock stream bottoms and is generally found clinging tightly to the underside of large rocks or between cracks in bedrock (Christman et al. 1996, p. 28). Historical habitats included large coastal plain river, large high-gradient rivers, and multiple upland tributary streams.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. Final Reclassification of the Tulotoma Snail From Endangered to Threatened. Page 31867. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-06-02/pdf/2011-13687.pdf
<u>Gonzales springsnail</u> (<u>Tryonia</u> <u>circumstriata</u>)	Habitat of the species is primarily soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41238. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf

	saltgrass (Taylor 1987, p. 38; Echelle et al. 2001, p. 5).		
<u>Lacy elimia (snail) (<i>Elimia crenatella</i>)</u>	<p>Lacy elimia typically inhabit highly oxygenated waters on rock shoals and gravel bars.</p> <p>Currently, the lacy elimia is only known to survive in three Coosa River tributaries-- Cheaha, Emauhee, and Weewoka Creeks, Talladega County, Alabama (Bogan and Pierson, 1993a).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers or other water bodies.	<p>USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 8.</p> <p>Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf</p>
<u>Rough hornsnail (<i>Pleurocera foremani</i>)</u>	Rough hornsnails are primarily found on gravel, cobble, bedrock, and mud in moderate currents. They have been collected at depths of 1 m (3.3 ft) to 3 m (9.8 ft) (Hartfield 2004, p. 132). The species appears to tolerate low-to- moderate levels of silt deposition (Sides 2005, p. 127).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2010. Determination of Endangered Status for the Georgia Pigtoe Mussel, Interrupted Rocksnail, and Rough Hornsnail and Designation of Critical Habitat; Final Rule. Page 67514.</p> <p>Available at: http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27417.pdf#page=2</p>
<u>Cylindrical lioplax (snail) (<i>Lioplax cyclostomaformis</i>)</u>	<p>The cylindrical lioplax is currently known only from approximately 24 kilometers (km) (15 miles (mi)) of the Cahaba River above the Fall Line in Shelby and Bibb counties, Alabama (Bogan and Pierson, 1993b).</p> <p>Habitat for the cylindrical lioplax is unusual for the genus,</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	<p>USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 4.</p> <p>Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf</p>

	as well as for other genera of viviparid snails. It lives in isolated mud deposits found under large rocks in the rapid flowing sections of stream and river shoals.		
<u>Flat pebblesnail</u> <u>(<i>Lepyrium showalteri</i>)</u>	<p>The flat pebblesnail is currently known from One site on the Little Cahaba River, Bibb County, and from a single shoal series on the Cahaba River above the Fall Line, Shelby County, Alabama (Bogan and Pierson, 1993b).</p> <p>The flat pebblesnail is found attached to clean, smooth stones in rapid currents of river shoals.</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 6. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf
<u>Painted rocksnail</u> <u>(<i>Leptoxis taeniata</i>)</u>	<p>The painted rocksnail is currently known from the lower reaches of three Coosa River tributaries-- Choccolocco Creek, Talladega County; Buxahatchee Creek, Shelby County (Bogan and Pierson, 1993a); and Ohatchee Creek, Calhoun County, Alabama (Pierson in litt, 1993).</p> <p>Painted rocksnails are found attached to cobble, gravel, or other hard substrates in the strong currents of riffles (a shallow area in a streambed that causes ripples in the water) and shoals. Adult rocksnails move very little, and females probably glue</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 10. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf

	their eggs to stones in the same habitat (Goodrich, 1922).		
<u>Plicate rocksnail</u> (<u>Leptoxis plicata</u>)	Plicate rocksnails inhabit shallow gravel and cobble shoals in flowing waters.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 14. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf
<u>Round rocksnail</u> (<u>Leptoxis ampla</u>)	<p>The round rocksnail is currently known from a shoal series in the Cahaba River, Bibb and Shelby counties, Alabama, and from the lower reach of the Little Cahaba River, and the lower reaches of Shade and Six-mile creeks in Bibb County, Alabama (Bogan and Pierson, 1993b).</p> <p>Painted rocksnails are found attached to cobble, gravel, or other hard substrates in the strong currents of riffles (a shallow area in a streambed that causes ripples in the water) and shoals. Adult rocksnails move very little, and females probably glue their eggs to stones in the same habitat (Goodrich, 1922).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2005. Final Recovery Plan for Six Mobile Basin Aquatic Snails. Page 12. Available at: http://ecos.fws.gov/docs/recovery_plan/051202.pdf
<u>Slender campeloma</u> (<u>Campeloma decampi</u>)	<i>Campeloma decampi</i> is typically found burrowing in soft sediment (sand and/or mud) or detritus. It does not appear abundant at any site, and the spotty distribution appears	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2000. Endangered Status for the Armored Snail and Slender Campeloma; Final Rule. Page 10034. Available at: http://ecos.fws.gov/docs/federal_register/fr3525.pdf

	consistent with other <i>Campeloma</i> species		
<u>Interrupted</u> (=Georgia) <u>Rocksnaail</u> (<i>Leptoxis</i> <i>foremani</i>)	Rocksnaails live in shoals, riffles, and reefs (bedrock outcrops) of small to large rivers. Their habitats are generally subject to moderate currents during low flows and strong currents during high flows. These snails live attached to bedrocks, boulders, cobbles, and gravel and tend to move little, except in response to changes in water level. They lay their adhesive eggs within the same habitat (Johnson 2004, p.116).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2010. Determination of Endangered Status for the Georgia Pigtoe Mussel, Interrupted Rocksnaail, and Rough Hornsnail and Designation of Critical Habitat; Final Rule. Page 67513. Available at: http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27417.pdf#page=2
<u>Hungerford's</u> <u>crawling water</u> <u>Beetle</u> (<i>Brychius</i> <i>hungerfordi</i>)	River/stream(moderate to fast flow), depth of few inches to few feet, inorganic substrate. (USFWS 2009, p 5) 1st, 2nd and 3rd order perennial streams (USFWS 2006, p 22)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS, Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>) 5 Year Review, 2009 Available at: http://ecos.fws.gov/docs/five_year_review/doc2584.pdf US FWS, Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>) Recovery Plan, 2006 Available at: http://ecos.fws.gov/docs/recovery_plan/060928a.pdf
<u>Coffin Cave</u> <u>mold beetle</u> (<i>Batrisodes</i> <i>texanus</i>)	Troglobitic habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Coffin Cave Mold Beetle (<i>Batrisodes texanus</i>) 5-Year Review: Summary and Evaluation Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3017.pdf

<u>Kretschmarr Cave mold beetle</u> (<i>Texamaurops reddelli</i>)	Their habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Tooth Cave Spider (<i>Neoleptoneta myopica</i>), Kretschmarr Cave Mold Beetle (<i>Texamaurops reddelli</i>), and Tooth Cave Pseudoscorpion (<i>Tartarocreagris texana</i>) 5-Year Review: Summary and Evaluation Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3018.pdf
<u>Tooth Cave ground beetle</u> (<i>Rhadine persephone</i>)	They spend their entire lives underground and are endemic to karst formations (caves, sinkholes, and other subterranean voids).	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas Page III Available at: http://ecos.fws.gov/docs/recovery_plan/940825.pdf
<u>Comal Springs riffle beetle</u> (<i>Heterelmis comalensis</i>)	High quality unpolluted groundwater and spring outflows that have low levels of salinity and turbidity. High-quality discharge water from springs and adjacent subterranean areas also help sustain habitat components, such as riparian vegetation that are essential to the Peck's cave amphipod, Comal Springs dryopid beetle, and Comal Springs riffle beetle. The two beetle species are thought to require water with adequate levels of dissolved oxygen for respiration (Brown 1987, p. 260; Arsuffi 1993, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2006. Designation of Critical Habitat for the Peck's Cave Amphipod, Comal Springs Dryopid Beetle, and Comal Springs Riffle Beetle; Proposed Rule. Page 40592. Available at: http://www.gpo.gov/fdsys/search/citation/result?FR.action=federalRegister.volume=2006&federalRegister.page=40588&publication=FR
<u>Comal Springs dryopid beetle</u> (<i>Stygoparnus comalensis</i>)	High quality unpolluted groundwater and spring outflows that have low levels of salinity and turbidity. High-quality discharge water from springs and adjacent subterranean areas also	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2006. Designation of Critical Habitat for the Peck's Cave Amphipod, Comal Springs Dryopid Beetle, and Comal Springs Riffle Beetle; Proposed Rule. Page 40592. Available at:

	help sustain habitat components, such as riparian vegetation that are essential to the Peck's cave amphipod, Comal Springs dryopid beetle, and Comal Springs riffle beetle. The two beetle species are thought to require water with adequate levels of dissolved oxygen for respiration (Brown 1987, p. 260; Arsuffi 1993, p. 18).		http://www.gpo.gov/fdsys/search/citation.result?FR.action=federalRegister.volume=2006&federalRegister.page=40588&publication=FR
<u>Saint Francis' satyr butterfly</u> (<i>Neonympha mitchellii francisci</i>)	The habitat occupied by this satyr consists primarily of wide wet meadows dominated by a high diversity of sedges (<i>Carex</i> spp.) and other wetland graminoids	The proposed dicamba DGA uses are not expected to overlap with wet meadows.	US FWS-Recovery Plan for Saint Francis' Satyr Butterfly Page 2 Available at: http://ecos.fws.gov/docs/recovery_plan/960423.pdf
<u>[Unnamed] ground beetle</u> (<i>Rhadine infernalis</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi (comments - 7). Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Helotes mold beetle</u> (<i>Batrisodes venyivi</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi (comments - 7). Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>[Unnamed] ground beetle</u> (<i>Rhadine exilis</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi (comments - 7). Available at:

	caves, produced by dissolution of bedrock)		http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Bee Creek Cave harvestman</u> (<i>Texella reddelli</i>)	Bee Creek Cave Harvestman inhabit limestone caves. They are only able to survive in caves that maintain stable temperatures and humidity (close to 100%). They have been found in caves both on the north and south side of the Colorado river. They live in 'karst' type of terrain , which is formed by "dissolution of calcium carbonate from limestone bedrock by mildly acidic groundwater.	The proposed dicamba DGA uses are not expected to overlap with caves.	USFWS-Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas U.S. Fish and Wildlife Service Page III Available at: http://ecos.fws.gov/docs/recovery_plan/940825.pdf
<u>Bone Cave harvestman</u> (<i>Texella reyesi</i>)	Caves and mesocavernous voids in karst limestone	The proposed dicamba DGA uses are not expected to overlap with caves.	USFWS Bone Cave Harvestman 5-Year Review Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3016.pdf
<u>Tooth Cave pseudoscorpion</u> (<i>Tartarocreagris texana</i>)	Their habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock). There are currently four caves that support the Tooth Cave pseudoscorpion (<i>Tartarocreagris texana</i>).	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS-Tooth Cave Spider (<i>Neoleptoneta myopica</i>), Kretschmarr Cave Mold Beetle (<i>Texamaurops reddelli</i>), and Tooth Cave Pseudoscorpion (<i>Tartarocreagris texana</i>) 5-Year Review: Summary and Evaluation Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3018.pdf

<u>Tooth Cave Spider</u> (<i>Lepioneta myopica</i>)	Their habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock). There are currently six caves known to contain the Tooth Cave spider (<i>Neoleptoneta myopica</i>).	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS Tooth Cave Spider, Kretschmarr Cave Mold Beetle, and Tooth Cave Pseudoscorpion 5-Year Review Page 2 Available at: http://ecos.fws.gov/docs/five_year_review/doc3018.pdf
<u>Cokendolpher Cave Harvestman</u> (<i>Texella cokendolpheri</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Government Canyon Bat Cave Spider</u> (<i>Neoleptoneta microps</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Madla's Cave Meshweaver</u> (<i>Cicurina madla</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf

<u>Robber Baron Cave Meshweaver</u> (<i>Cicurina baronia</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Government Canyon Bat Cave Meshweaver</u> (<i>Cicurina vespera</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Braken Bat Cave Meshweaver</u> (<i>Cicurina venii</i>)	Caves and mesocavernous voids in karst limestone (landforms and subsurface features, for example, sinkholes and caves, produced by dissolution of bedrock)	The proposed dicamba DGA uses are not expected to overlap with caves.	U.S. Fish and Wildlife Service. 2011. Bexar County Karst Invertebrates Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM. Page vi Available at: http://ecos.fws.gov/docs/recovery_plan/Final%202001%20Bexar%20Co%20Invertebrates%20Rec%20Plan_1.pdf
<u>Peck's cave amphipod</u> (<i>Stygobromus</i> (= <i>Stygonectes</i>) <i>pecki</i>)	High quality unpolluted groundwater and spring outflows that have low levels of salinity and turbidity. High-quality discharge water from springs and adjacent subterranean areas also help sustain habitat components, such as riparian vegetation that are essential to the Peck's cave amphipod, Comal Springs dryopid beetle, and Comal Springs riffle beetle. The two beetle species	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2006. Designation of Critical Habitat for the Peck's Cave Amphipod, Comal Springs Dryopid Beetle, and Comal Springs Riffle Beetle; Proposed Rule. Page 40592. Available at: http://www.gpo.gov/fdsys/search/citation.result?FR.action=federalRegister.volume=2006&federalRegister.page=40588&publication=FR

	are thought to require water with adequate levels of dissolved oxygen for respiration (Brown 1987, p. 260; Arsuffi 1993, p. 18).		
<u>Alabama cave shrimp</u> (<i>Palaemonias alabamae</i>)	Silt-bottomed cave pools (USFWS 1997)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS, Alabama Cave Shrimp (<i>Palaemonias alabamae</i>) 5 year review, 2006. Available at: http://ecos.fws.gov/docs/five_year_review/doc747.pdf US FWS, Alabama Cave Shrimp (<i>Palaemonias alabamae</i>) recovery plan, 1997. Available at: http://ecos.fws.gov/docs/recovery_plan/970904.pdf
<u>Kentucky cave shrimp</u> (<i>Palaemonias ganteri</i>)	Very specific habitat requirements- large, base level passages of caves characterized by slow flow, abundant organic matter, and coarse to fine grain sand and coarse silt sediments.	The proposed dicamba DGA uses are not expected to overlap with caves.	US FWS, Kentucky Cave shrimp completed 5-year review, 2010. Page 5. Available at: http://ecos.fws.gov/docs/five_year_review/doc3203.pdf
<u>Diminutive Amphipod</u> (<i>Gammarus hyalleloides</i>)	Amphipods in the <i>Gammarus pecos</i> species complex occur only in desert spring outflow channels on substrates, often within interstitial spaces on and underneath rocks and within gravels (Lang et al. 2003, p. 49) and are most commonly found in microhabitats with flowing water. They are also commonly found in dense stands of submerged vegetation (Cole 1976, p. 80). Because of their affinity for constant water	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates: Final Rule. Page 41238. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-07-09/pdf/2013-16222.pdf

	temperatures, they are most common in the immediate spring outflow channels, usually only a few hundred meters downstream of spring outlets.		
<u>Alabama pearlshell</u> (<i>Margaritifera marrianae</i>)	The Alabama pearlshell typically inhabits small headwater streams with mixed sand and gravel substrates, occasionally in sandy mud, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule. Page 61667</u>
<u>Altamaha Spinemussel</u> (<i>Elliptio spinosa</i>)	This spinymussel is considered a “big river” species; is associated with stable, coarse-to-fine sandy sediments of sandbars, sloughs, and mid-channel islands; and appears to be restricted to swiftly flowing water (Sickel 1980, p. 12).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. <u>Endangered Status for the Altamaha Spinemussel and Designation of Critical Habitat: Final Rule. Page 62928</u>
<u>Carolina heelsplitter</u> (<i>Lasmigona decorata</i>)	It has been recorded from a variety of substrates (including mud, clay, sand, gravel, and cobble/boulder/bedrock) without significant silt accumulations, along stable, well-shaded stream banks (Keferl and Shelly 1988, Keferl 1991). However, individuals have also been found near the center of the stream channel in relatively silt-free substrates comprised primarily of a mixture of sand, gravel, and cobble, with scattered areas of	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F02L.html

	exposed boulders/ bedrock (J. Fridell personal observation, 1995).		
<u>Chipola slabshell</u> (<i>Elliptio chipolaensis</i>)	The Chipola slabshell inhabits silty sand substrates of large creeks and the main channel of the Chipola River in slow to moderate current (Williams and Butler 1994). Specimens are generally found in sloping bank habitats. Nearly 70 percent of the specimens found during the status survey were associated with a sandy substrate (Brim Box and Williams 2000).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
<u>Choctaw bean</u> (<i>Villosa choctawensis</i>)	It is found in medium creeks to medium rivers in stable substrates of silty sand to sandy clay with moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Final rule. Page 61669</u>
<u>Cracking pearlymussel</u> (<i>Hemistena lata</i>)	The cracking pearlymussel inhabits streams of moderate size on gravel riffles where it is often deeply buried in the substrate (Bogan and Parmalee 1983). Substrate preferences include sand, gravel, and cobble in high velocity areas and mud and sand in slower moving waters (Gordon and Layzer 1989).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F01X.html

<u>Cumberland elktoe</u> <u>(<i>Alasmidonta</i> <i>atropurpurea</i>)</u>	This species inhabits medium-sized rivers and may extend into headwater streams where it is often the only mussel present (Gordon and Layzer 1989, Gordon 1991). Gordon and Layzer (1989) reported that the species appears to be most abundant in flats, which were described by Gordon (1991) as shallow pool areas lacking the bottom contour development of typical pools, with sand and scattered cobble/boulder material, relatively shallow depths, and slow (almost imperceptible) currents. They also report the species from swifter currents and in areas with mud, sand, and gravel substrates.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2004. <u>Cumberland and Tennessee River Mussels (5 spp.)</u> Page 18.
<u>Dark pigtoe</u> <u>(<i>Pleurobema</i> <i>furvum</i>)</u>	Sand/gravel/cobble shoals and rapids in small rivers and large streams.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2000. <u>Recovery Plan for the Mobile River Basin (15 species)</u> . Page 53
<u>Dwarf wedgemussel</u> <u>(<i>Alasmidonta</i> <i>heterodon</i>)</u>	The dwarf wedge mussel lives on muddy sand, sand, and gravel bottoms in creeks and rivers of varying sizes, in areas of slow to moderate current and little silt deposition.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1993. <u>Dwarf Wedge Mussel</u> recovery plan. Page 3.
<u>Fat three-ridge (mussel)</u> <u>(<i>Amblema</i> <i>neislerii</i>)</u>	The fat three-ridge inhabits the main channel of small to large rivers in slow to moderate current. Substrate used by this mussel varies from gravel to cobble to a	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. <u>Recovery Plan for 7 mussels</u> . Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf

	mixture of sand and sandy mud (Williams and Butler 1994). Brim Box and Williams (2000) found 60 percent of the specimens were located in a sandy silt substrate.		
<u>Flat pigtoe</u> (<i>Pleurobema marshalli</i>)	The flat pigtoe, like other Tombigbee River system mussels, inhabits moderate to large rivers with moderate to swift current. Its preferred habitat is riffle-run or shoal areas with stable substrates ranging from sandy gravel to gravel-cobble (Stanbery 1976, 1980, 1983). Unionids collected from the Tombigbee River system have been collected in water up to 0.7 meters deep (USFWS 1987).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F013.html
<u>Fuzzy pigtoe</u> (<i>Pleurobema strodeanum</i>)	The fuzzy pigtoe is found in medium creeks to medium rivers in stable substrates of sand and silty sand with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Final rule. Page 61673</u>
<u>Gulf moccasinshell</u> (<i>Medionidus penicillatus</i>)	The Gulf moccasinshell inhabits the channels of small to medium-sized creeks to large rivers with sand and gravel or silty sand substrates in slow to moderate currents (Williams and Butler 1994; Garner, pers. comm. 2003).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. <u>Recovery Plan for 7 mussels. Page 43.</u> http://ecos.fws.gov/docs/recovery_plan/030930.pdf

Heavy pigtoe (<i>Pleurobema latianum</i>)	The heavy pigtoe, like other Tombigbee River system mussels, inhabits moderate to large rivers with moderate to swift current. Its preferred habitat is riffle-run or shoal areas with stable substrates ranging from sandy gravel to gravel-cobble (Stanbery 1976, 1980, 1983). Unionids collected from the Tombigbee River system have been collected in water up to 0.7 meters deep (USFWS 1987).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F014.html
James spinymussel (<i>Pleurobema collina</i>)	This species lives in stream sites that vary in width from 10-75 feet and depth of 1/2 to 3 feet. It requires a slow to moderate water current with clean sand and cobble bottom sediments. The James spinymussel is limited to areas of unpolluted water, and may be more susceptible to competition from exotic clam species when its habitat is disturbed (Clark and Neves 1984, USFWS 1990).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F025.html
Narrow pigtoe (<i>Fusconaia escambia</i>)	It is found in medium creeks to medium rivers, in stable substrates of sand, sand and gravel, or silty sand, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule, Page 61671

Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)	The Ochlockonee moccasinshell inhabits large creeks and the Ochlockonee River main stem in areas with current. Typical substrates are sand with some gravel (Williams and Butler 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Oval pigtoe (<i>Pleurobema pyriforme</i>)	The oval pigtoe occurs in small to medium-sized creeks to small rivers where it inhabits silty sand to sand and gravel substrates, usually in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Stream channels appear to offer the best habitat for this species.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Purple bankclimber (mussel) (<i>Elliptioideus sloatianus</i>)	The purple bankclimber inhabits small to large river channels in slow to moderate current over sand or sand mixed with mud or gravel substrates (Williams and Butler 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Ring pink (mussel) (<i>Obovaria retusa</i>)	The ring pink inhabits gravel and sandy substrates in large rivers of the Ohio River basin	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS, 1991. Ring Pink Mussel Recovery Plan. Page 4. http://ecos.fws.gov/docs/recovery_plan/910325.pdf
Round Ebonyshell (<i>Fusconaia rotulata</i>)	It occurs in small to medium rivers, typically in stable substrates of sand, small gravel, or sandy mud in slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668

Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)	The shinyrayed pocketbook inhabits small to medium-sized creeks, to rivers in clean or silty sand substrates in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Specimens are often found in the interface of stream channel and sloping bank habitats, where sediment particle size and current strength are transitional. Clench and Turner (1956) noted it preferred small creeks and spring-fed rivers.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Southern acornshell (<i>Epioblasma othcaloogensis</i>)	The southern acornshell was historically restricted to shoals in small rivers to Small streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2000. Recovery Plan for the Mobile River Basin (15 species). Page 57
Southern kidneyshell (<i>Ptychobranhus jonesi</i>)	It is typically found in medium creeks to small rivers in firm sand substrates with slow to moderate current (Williams et al. 2008, pp. 625).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668
Southern sandshell (<i>Hamiota (=Lampsilis) australis</i>)	The southern sandshell is typically found in small creeks and rivers in stable substrates of sand or mixtures of sand and fine gravel, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61672

Tapered pigtoe (<i>Fusconaia burkei</i>)	The tapered pigtoe is found in medium creeks to medium rivers in stable substrates of sand, small gravel, or sandy mud, with slow to moderate current (Williams et al. 2008, p. 296).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Final rule. Page 61670</u>
Tar River spinymussel (<i>Elliptio steinstansana</i>)	The preferred habitat of the Tar spinymussel appears to be relatively fast-flowing, well-oxygenated water, in sites with a substrate comprised of relatively silt-free, uncompacted gravel and coarse sand (USFWS 1992).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F015.html
Upland combshell (<i>Epioblasma metastrata</i>)	Restricted to shoals in rivers and large streams above the Fall Line. It was found on stable sand/gravel/cobble substrate in moderate to swift currents.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2000. <u>Recovery Plan for the Mobile River Basin (15 species). Page 61</u>
Yellow blossom (pearl)mussel (<i>Epioblasma florentina florentina</i>)	Riverine and typically found in streams which are shallow with sandy-gravel substrate with rapid currents (Stansbery, 1971)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1985. <u>Recovery plan for three mussels. Page 20.</u> http://ecos.fws.gov/docs/recovery_plan/850125.pdf
Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)	The only known locality at which the Alabama cavefish occurs is Key Cave in Lauderdale county, Alabama. Low temperature and periodic flooding are characteristic of the aquatic habitat in caves (USFWS 1990)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1990. <u>Alabama cavefish recovery plan. Page 2. Available online at:</u> http://ecos.fws.gov/docs/recovery_plan/901025.pdf

<u>Alabama sturgeon</u> (<i>Scaphirhynchus suttkusi</i>)	Very little is known of the habitat requirements of the Alabama Sturgeon. Based on capture data, it inhabits the main channel of large coastal plain rivers of the Mobile River Basin. Most specimens have been taken in moderate to swift current at depths of 6 to 14 m, over sand, gravel or mud bottom (Williams and Clemmer 1991). (USFWS 2013)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2013. <u>Recovery Plan for the Alabama Sturgeon</u> (<i>Scaphirhynchus suttkusi</i>). Page 13.
<u>Big Bend gambusia</u> (<i>Gambusia gaigei</i>)	The Big Bend gambusia is restricted to small, desert spring habitats. The spring ponds at Rio Grande Village that harbor the fish are clear warm water, stenothermal (constant temperature) springs. Hubbs (2001, pp. 315-316) documented the average outflow temperatures of Spring 4 and Spring 1 as 34.9 °C (95°F) and 33.1°C (92°F), respectively, with very low variability. The Big Bend gambusia is often found associated with dense stands of Chara spp. (submerged plant) and emergent vegetation in the refuge ponds (Hubbs et al. 2002, p. 82).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Big Bend gambusia - 5 year review</u> . Page 8.
<u>Cahaba shiner</u> (<i>Notropis cahabae</i>)	The habitat of the Cahaba shiner appears to be large shoal areas in the main channel of the Cahaba river (Howell et al. 1982). The species is found in the quieter waters, less	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1992. Cahaba shiner (<i>Notropis cahabae</i>) Recovery plan. Pages 1-3. Available at: http://ecos.fws.gov/docs/recovery_plan/920423.pdf

	<p>than 1.6 feet (0.5 meters) deep, just below swift riffle areas (Howell et al. 1982). The Cahaba shiner seems to prefer sandy patches in gravel beds or downstream of larger rocks and boulders. The species is generally found in relatively clear, well oxygenated water. It probably requires a river with sufficient small crustaceans, insect larvae, and algae for food, similar to its close relatives (Gilbert and Burgess 1980). (USFWS 1992)</p>		
<p><u>Cape Fear shiner (<i>Notropis mekistocholas</i>)</u></p>	<p>The Cape Fear shiner is generally associated with gravel, cobble, and boulder substrate, and it has been observed inhabiting slow pools, riffles, and slow runs often associated with water willow (<i>Justicia</i>) beds (Palmer and Braswell, North Carolina State Museum of Natural History, personal communication, 1986; Pottem and Huish 1985, 1986; Snelson 1971).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1988. Cape Fear shiner Recovery Plan. Page 1. Available at: http://ecos.fws.gov/docs/recovery_plan/060313.pdf</p>
<p><u>Cherokee darter (<i>Etheostoma scotti</i>)</u></p>	<p>Cherokee darters inhabit small to medium size warm-water creeks of moderate gradient with predominantly rocky bottoms. They are usually found in shallow water sections of reduced currents typically in areas above and below riffles and at the ecotones of riffles</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1994. <u>ETWP: Determination of Threatened Status for the Cherokee Darter and Endangered Status for the Etowah Darter</u>. Page 65506.</p>

	<p>and backwaters. Moreover, this species as associated with large gravel, cobble, and small boulder substrates, and is uncommonly, or rarely found over bedrock, fine gravel, or sand. It is most abundant in stream sections with relatively clear water and clean substrates (little Silt deposition). (USFWS 1994)</p> <p>The Cherokee darter is endemic to the Etowah River system in north Georgia where it is primarily restricted to streams draining the Piedmont physiographic province, and to a lesser extent, the Blue Ridge physiographic province. (USFWS 1994)</p>		
<p><u>Clear Creek gambusia</u> (<i>Gambusia heterochir</i>)</p>	<p>This species is restricted to the Clear Creek headspring pool that is characterized as clear, stenothermal, low pH (6.1 - 6.5) water with abundant aquatic vegetation composed mostly of an endemic, undescribed morph of <i>Ceratophyllum sp.</i></p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1982. <u>Recovery Plan for Clear Creek Gambusia</u>. Pages 2-3.</p> <p>Life Histories: Clear Creek Gambusia (<i>Gambusia heterochir</i>). http://ecos.fws.gov/docs/life_histories/E005.html</p>
<p><u>Comanche Springs pupfish</u> (<i>Cyprinodon elegans</i>)</p>	<p>The present habitat of the species consists mostly of a system of earthen and concrete irrigation canals. The water from Phantom Lake Spring is diverted into agricultural fields or sometimes flows down Phantom Lake Canal to merge with the</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 1981. Recovery Plan for the Comanche Springs Pupfish. Page 2. Available at: http://ecos.fws.gov/docs/recovery_plan/051221a.pdf</p>

	flow from San Solomon Spring.		
<u>Devils River minnow</u> <i>(Dionda diaboli)</i>	<p>(1) Streams characterized by:</p> <p>a. Areas with slow to moderate water velocities between 10 and 40 cm/second (4 and 16 in/second) in shallow to moderate water depths between approximately 10 cm (4 in) and 1.5 m (4.9 ft), near vegetative structure, such as emergent or submerged vegetation or stream bank riparian vegetation that overhangs into the water column;</p> <p>b. Gravel and cobble substrates ranging in diameter between 2 and 10 cm (0.8 and 4 in) with low or moderate amounts of fine sediment (less than 65 percent stream bottom coverage) and low or moderate amounts of substrate embeddedness; and</p> <p>c. Pool, riffle, run, and backwater components free of artificial instream structures that would prevent movement of fish upstream or downstream.</p> <p>(2) High-quality water provided by permanent, natural flows from groundwater springs</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS 2008. Designation of Critical Habitat for the Devils River Minnow; Final rule. 73 FR 46988 47026. Page 47001. Available at: http://www.gpo.gov/fdsys/pkg/FR-2008-08-12/pdf/E8-17985.pdf#page=1</p>

	<p>and seeps characterized by:</p> <ul style="list-style-type: none"> a. Temperature ranging between 17°C and 29°C; b. Dissolved oxygen levels greater than 5.0 mg/l; c. Neutral pH ranging between 7.0 and 8.2; d. Conductivity less than 0.7 mS/cm and salinity less than 1 ppt; e. Ammonia levels less than 0.4 mg/l; and f. No or minimal pollutant levels for copper, arsenic, mercury, and cadmium; human and animal waste products; pesticides; fertilizers; suspended sediments; and petroleum compounds and gasoline or diesel fuels. <p>(3) Abundant aquatic food base consisting of algae; attached to stream substrates; and other microorganisms associated with stream substrates.</p> <p>(4) Aquatic stream habitat either devoid of nonnative aquatic species (including fish, plants, and invertebrates) or in which such nonnative aquatic species are at levels that allow for healthy populations of Devils River minnows.</p> <p>(5) Areas within stream courses that may be periodically dewatered for short time periods,</p>		
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	during seasonal droughts, but otherwise serve as connective corridors between occupied or seasonally occupied areas through which the species moves when the area is wetted. (USFWS 2008)		
<u>Etowah darter</u> <u>(<i>Etheostoma etowahae</i>)</u>	The Etowah darter inhabits warm and cool, medium and large creeks or small rivers that are moderate or high gradient with rocky bottoms and relatively shallow riffles and large gravel, cobble, and small boulder substrates. (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	1994. USFWS ETWP; Determination of Threatened Status for the Cherokee Darter and Endangered Status for the Etowah Darter. Page 65506. Available at: http://ecos.fws.gov/docs/federal_register/fr2753.pdf
<u>Fountain darter</u> <u>(<i>Etheostoma fonticola</i>)</u>	The fountain darter requires: 1) undisturbed stream floor habitats (including runs, riffles, and pools), 2) a mix of submergent vegetation (algae, mosses, and vascular plants) in part for cover, 3) clear and clean water, 4) constant water temperatures within the natural and normal river gradients, and 5) most importantly, adequate springflows. In general, <i>E. fonticola</i> prefers vegetated stream-floor habitats with constant water temperature. Higher densities of the fish are found in mats of the filamentous green algae (<i>Rhizoclonium sp.</i>) and the moss <i>Riccia</i> . It is occasionally found in areas lacking vegetation. Fountain	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1996. San Marcos and Comal springs and associated aquatic ecosystems (revised) recovery plan. Page 33. Available at: http://ecos.fws.gov/docs/recovery_plan/960214.pdf

	darters have also been observed among leaf litter in the Comal River. (USFWS 1996)		
<u>Goldline darter</u> <u>(<i>Percina</i></u> <u><i>aurolineata</i>)</u>	Prefers a moderate to swift current and water depths greater than 2 feet (Howell et al. 1982). It is found over sand or gravel substrate interspersed among cobble and small boulders. (USFWS 1992)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	1992. USFWS ETWP; Threatened Status for Two Fish, the Goldline Darter (<i>Percina aurolineata</i>) and Blue Shiner (<i>Cyprinella caerulea</i>). Page 14786. http://ecos.fws.gov/docs/federal_register/fr2036.pdf
<u>Leon Springs pupfish</u> <u>(<i>Cyprinodon</i></u> <u><i>bovinus</i>)</u>	The Leon Springs pupfish inhabits highly saline habitat preferring quiet waters near the edge of shallow pools with a minimal growth of vegetation. (USFWS 1980)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	1980. USFWS ETWP; Listing of Leon Springs pupfish as endangered with critical habitat. Page 14786. http://ecos.fws.gov/docs/federal_register/fr457.pdf
<u>Palezone shiner</u> <u>(<i>Notropis</i></u> <u><i>albizonatus</i>)</u>	The palezone shiner occurs in flowing pools and runs of upland streams that have permanent flow, clear water, and substrates composed of bedrock, cobble, pebble, and gravel mixed with clean sand (USFWS 1997). In May 1990, Warren et al. (1994) collected the species in the PRR from pools (60-75 cm depth) over fine to coarse gravel mixed with sand. In June 1990, Warren et al. (1994) observed the species in shallow (30-45 cm, 1.2-1.8 in) runs and pools of the Little South Fork that were underlain by fractured bedrock and scattered gravel patches. In	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2014. Palezone shiner (<i>Notropis albizonatus</i>) 5-year review: summary and evaluation. US Fish and Wildlife Service Southeast Region Kentucky Ecological Services Field Office John C. Watts Federal Building 330 West Broadway, Room 265 Frankfort Kentucky, 40601. Page 8. http://ecos.fws.gov/docs/five_year_review/doc4374.pdf

	<p>August 1990, they collected individuals in the Little South Fork from pools and runs with current velocities ranging from 0.6-4.5 cm/sec (0.02-0.15 feet/sec) and mean depth of 59 cm (2.3 in). Substrates varied from sand mixed with fine and coarse gravel to bedrock. Shepard et al. (1997) reported the species from pools and runs of the PRR that had substrates composed of a mixture of cobble, gravel, and sand. Water depths ranged from 30.5-76.2 cm (12-30 in). (USFWS 2014)</p>		
<u>Pecos gambusia</u> <u>(<i>Gambusia nobilis</i>)</u>	<p><i>Gambusia nobilis</i> occurs abundantly in springheads and spring runs. Moderately abundant populations are also known from areas with little spring influence, but with abundant overhead cover, sedge covered marshes, and gypsum sinkholes. <i>G. nobilis</i> has been observed to occur from the surface to depths of three meter.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS ECOS Life Histories for the Pecos gambusia (<i>Gambusia nobilis</i>)</p> <p>http://ecos.fws.gov/docs/life_histories/E00V.html</p>
<u>Pygmy Sculpin</u> <u>(<i>Cottus paulus</i> (=pygmaeus))</u>	<p>Gravel and sand substrate. Habitat also contains large rocks where the spring boils occur.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>Life Histories: Pygmy sculpin (<i>Cottus paulus</i> (=pygmaeus)).</p> <p>http://ecos.fws.gov/docs/life_histories/E01L.html</p>
<u>Relict darter</u> <u>(<i>Etheostoma chienense</i>)</u>	<p>Adults are concentrated in headwaters of streams in slow flowing pools (0.2-0.6 m/sec), usually over gravel mixed with sand and under or near cover</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>2013. US Fish and Wildlife Service Southeast Region, Relict darter (<i>Etheostoma chienense</i>) Five Year Review Summary and Evaluation, Page 8.</p>

	such as fallen tree branches, undercut banks, or overhanging riparian vegetation. (USFWS 2013)		https://ecos.fws.gov/docs/five_year_review/doc4178.pdf
<u>Rush Darter</u> <u>(<i>Etheostoma</i></u> <u><i>phytophilum</i>)</u>	Habitats tend to be shallow, clear, and cool, with moderate current and substrates composed of a combination of sand with silt, muck, gravel or bedrock. (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	Fish and Wildlife Service Department of the Interior, 2012, Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Cumberland darter, Rush darter, Yellowcheek darter, Chucky madtom, and Laurel dace, Volume 77 No. 200, Page 63605 http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24468.pdf
<u>San Marcos gambusia</u> <u>(<i>Gambusia</i></u> <u><i>georgei</i>)</u>	The San Marcos gambusia apparently prefers quiet waters adjacent to sections of moving water, but seemingly of greatest importance, thermally constant waters. <i>G. georgei</i> is found mostly over muddy substrates but generally not silted habitats, and shade from over-hanging vegetation or bridge structures is a factor common to all sites along the upper San Marcos River where apparently suitable habitats for this species occur (Hubbs and Peden 1969, Edwards et. al. 1980).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1996. San Marcos and Comal springs and associated aquatic ecosystems (revised) recovery plan. Page 29. Available at: http://ecos.fws.gov/docs/recovery_plan/960214.pdf
<u>Sharpnose Shiner</u> <u>(<i>Notropis</i></u> <u><i>oxyrhynchus</i>)</u>	Sharpnose shiners occur in fairly shallow, flowing water, often less than 0.5 m (1.6 ft) deep with sandy substrates... minimum estimated reach length	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2014. Designation of Critical Habitat for Sharpnose Shiner and Smalleye Shiner; Final Rule. Page 45250.

	requirements for similar species and current modeling efforts for this species indicate an unobstructed reach length of greater than 275 km (171 mi) is likely required to complete the species' life history.		
<u>Shortnose sturgeon</u> <u>(<i>Acipenser brevirostrum</i>)</u>	Shortnose sturgeon are found in rivers, estuaries, and the sea, but populations are confined mostly to natal rivers and estuaries. The species appears to be estuarine anadromous in the southern part of its range, but in some northern rivers it is "freshwater amphidromous", i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life (Kieffer and Kynard 1993). Adults in southern rivers forage at the interface of fresh tidal water and saline estuaries and enter the upper reaches of rivers to spawn in early spring (Savannah River: Hall et al. 1991; Altamaha River: Heidt and Gilbert 1979; Flourenoy et al. 1992, Rogers and Weber 1995a; Ogeechee River: Weber 1996).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS 1998. Final Recovery Plan for the Shortnose Sturgeon (<i>Acipenser brevirostrum</i>). Page 25. Available at: http://ecos.fws.gov/docs/recovery_plan/sturgeon_shortnose_1.pdf

<u>Smalltooth sawfish (<i>Pristis pectinata</i>)</u>	Generally inhabit the shallow coastal waters of bays, banks, estuaries and river mouths, particularly shallow mud banks and mangrove habitats. Larger animals can be found in the same habitat, but are also found offshore at depths up to least 122 meters.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	National Marine Fisheries Service, 2009, Smalltooth sawfish Recovery Plan. Page v. http://ecos.fws.gov/docs/recovery_plan/smalltoothsawfish.pdf
<u>Sunfish, spring pygmy (<i>Elassoma alabamae</i>)</u>	Clear to slightly stained spring water, occurring within spring heads (where cool water emerges from the ground), spring pools (water pool at spring head), spring runs (stream or channel downstream of spring pool), and associated spring-fed wetlands... occupying depths from 13 to 102 cm (in water column)... prefers patches of dense filamentous submergent vegetation	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	Endangered and Threatened Wildlife and Plants; Threatened Species Status for Spring Pygmy Sunfish, Federal Register, 2013, 78(191): 60766-60783. Page 60768. http://www.gpo.gov/fdsys/pkg/FR-2013-10-02/pdf/2013-23726.pdf
<u>Vermilion darter (<i>Etheostoma chermocki</i>)</u>	Small to medium-sized clear streams, with gravel riffles and moderate currents (Kuehne and Barbour, 1983; Etnier and Starnes, 1993). Boschung et al. (1992) described the stream habitat for vermilion darters as 3 to 20 m wide, 0.01 to more than 0.5 m in depth, with pools of moderate current alternating with riffles of moderately swift current, and low water turbidity. Blanco and Mayden (1999) found this species	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	Daniel J Drennen and the Vermilion Darter Recovery Team / US Fish and Wildlife Service Department of Interior, 2007, Recovery Plan Vermilion Darter, Page 11 http://ecos.fws.gov/docs/recovery_plan/070802.pdf

	primarily in areas dominated by fine gravel with some coarse gravel or cobble. This species is absent in habitats with only a bedrock bottom, but has been found on bedrock with sand and gravel... This species is generally not found in deeper pool habitats.		
<u>Waccamaw silverside</u> (<u>Menidia extensa</u>)	The species is usually found in schools near the surface. It forages in areas of shallow, open water over a clean, dark sand substrate with no vegetation and spawn in open-water areas near the shoreline.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS Life histories document. http://ecos.fws.gov/docs/life_histories/E01P.html
<u>Watercress darter</u> (<u>Etheostoma nuchale</u>)	Prefer deeper, slow moving backwater areas of springs that are choked with aquatic vegetation such as watercress (<i>Nasturtium</i>), and algae (<i>Chara</i> and <i>Spirogyra</i>).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS Life Histories Watercress darter (<i>Etheostoma nuchale</i>) http://ecos.fws.gov/docs/life_histories/E00U.html

Species	Habitat	Rationale	Source
Plants			
<u>Avens spreading</u> (<u>Geum radiatum</u>)	This species grows in full sun on the shallow acidic soils of high-elevation cliffs, rocky outcrops, steep slopes, and on gravelly talus (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with high-elevation cliffs, rocky outcrops, steep slopes or gravelly talus.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930428.pdf
<u>Bluet. Roan Mountain</u> (<u>Hedysotis purpurea var. montana</u>)	This species grows in shallow soils and crevices of cliffs and outcrops and on thin rocky soils of grassy balds (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with cliffs and outcrops.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960513.pdf

Species	Habitat	Rationale	Source
<u>Chaffseed</u> <u>American</u> <u>(Schwalbea</u> <u>americana)</u>	Habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with pine flatwoods, fire-maintained savannas, wetland or sedge dominated systems.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950929c.pdf
<u>Clover, running</u> <u>buffalo</u> <u>(Trifolium</u> <u>stoloniferum)</u>	Running buffalo clover occurs in mesic habitats of partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).	The proposed dicamba DGA uses are not expected to overlap with mesic habitats where the clover is expected to be found.	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

Species	Habitat	Rationale	Source
<u>Daisy, Lakeside</u> <u>(<i>Hymenoxys</i></u> <u><i>herbacea</i>)</u>	Although historical habitats include outcrops of dolomite or limestone bedrock, dry, gravelly prairies on terraces or hills associated with major river systems, rocky shores, sandy fields and alvars, the Lakeside daisy in the U. S. is now restricted to dry, thin-soiled, degraded prairies in which limestone or dolomite bedrock is at or near the surface. Habitats are alkaline, seasonally wet in spring and fall, and are moderately to extremely droughty in summer. Typically, habitats have little topographic relief, are relatively open at the ground surface, and vegetation density and diversity are relatively low. Within these habitats, lakeside daisy occurs in open patches of ground, occupies the dry to mesic portions of the soil moisture continuum and has a highly aggregated distribution. This species is either absent or infrequently found in shaded or densely vegetated areas (US FWS, 1990, pp. 20-21).	The proposed dicamba DGA uses are not expected to overlap with quarries and dry prairies.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf
<u>Fern, American</u> <u>hart's-tongue</u> <u>(<i>Asplenium</i></u> <u><i>scolopendrium</i></u> <u>var.</u> <u><i>americanum</i>)</u>	Early successional habitats Northern populations occur in forests of secondary growth where canopy openings are abundant. New York populations	The proposed dicamba DGA uses are not expected to overlap early successional forests, conifer forests or bryophyte beds where the species is found.	http://ecos.fws.gov/docs/recovery_plan/930915.pdf

Species	Habitat	Rationale	Source
	occur in conifer forests. Bryophyte beds are an important substrate.		
Fleshy-fruit gladeceess (<i>Leavenworthia crassa</i>) ²	PCEs: (1) Shallow-soiled, open areas with exposed limestone bedrock or gravel that are dominated by herbaceous vegetation characteristic of glade communities. (2) Open or well-lighted areas of exposed limestone bedrock or gravel that ensure fleshy-fruit gladeceess plants remain unshaded for a significant portion of the day. (3) Glade habitat that is protected from both native and invasive, nonnative plants to minimize competition and shading of fleshy-fruit gladeceess.	Technical consultation with USFWS biologist indicated that this species will not persist in soy or cotton fields due to the competing vegetation.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q12K#crittab http://www.gpo.gov/fdsys/pkg/FR-2014-08-26/pdf/2014-19558.pdf <u>Email communication (Holbrook, S. (2015, June 17).</u>
<u><i>Geocarpon minimum</i> (No common name)</u>	This species grows on sandstone glades and outcrops as well as bare, sparsely vegetated areas where the soil contains relatively large amounts of magnesium and sodium salts (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with the sandstone glades and outcrops where this species is expected to be found.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930726.pdf
<u>Goldenrod, Blue Ridge (<i>Solidago spithamea</i>)</u>	This species grows on rock outcrops and vertical to near vertical cliffs in southern Appalachians of western North Carolina and extreme eastern TN. Rocky summits and cliffs usually appear as smaller-scale patchy habitats embedded in larger	The proposed dicamba DGA uses are not expected to overlap with rock outcrops and vertical cliffs.	USFWS. 1987. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/blueridge%20goldenrod%20r p.pdf

² Bold text indicates the four species with effects determination “may affect, likely to adversely affect”.

Species	Habitat	Rationale	Source
	forest consisting of spruce-fir or northern hardwoods or occasionally high elevation red oak forest (US FWS, 1987).		
<u>Grass, Tennessee yellow-eyed (Xyris tennesseensis)</u>	<i>Xyris tennesseensis</i> is a rare perennial monocot that is an obligate wetland plant that prefers relatively high pH seeps and streambanks. An Obligate wetland plant that is restricted to calcareous seeps, fens, and spring runs (US FWS, 2014).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 2014. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4360.pdf
<u>Harperella (Ptilimnium nodosum)</u>	Harperella is known from only two locations in North Carolina. One population occurs in the Tar River in Granville County. Another population was reintroduced to the Deep River recently after the original population known from that area disappeared. This population occurs in Chatham County, but the river serves as the divide between Chatham and Lee counties (US FWS, 1991).	The proposed dicamba DGA uses are not expected to overlap with river habitats.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910305b.pdf
<u>Iris, dwarf lake (Iris lacustris)</u>	The dwarf lake iris grows along the northern shorelines of lakes Michigan and Huron in Wisconsin, Michigan and Ontario, Canada. It typically occurs in shallow soil over moist calcareous sands, gravel and beach rubble. Sunlight is one	The proposed dicamba DGA uses are not expected to overlap with shoreline coniferous forests.	USFWS. 2013. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/DLI%20RP%20FINAL%20AUG2013_1.pdf

Species	Habitat	Rationale	Source
	of the most critical factors to the growth and reproduction of the species and partly shaded or sheltered forest edges are optimal for sexual reproduction. Some form of disturbance is also required to maintain the forest openings that provide these partial shade conditions. The species is most often associated with shoreline coniferous forests dominated by northern white cedar and balsam fir. The principal limiting factor for dwarf lake iris is the availability of this suitable shoreline habitat (US FWS, 2013, pp. 6-7).		
<u>Lichen, rock gnome</u> <u>(<i>Gymnoderma lineare</i>)</u>	<p>Rock gnome lichen is primarily limited to vertical rock faces where seepage water from forest soils above flows during (and only during) very wet times. It appears the species needs a moderate amount of light, but that it cannot tolerate high-intensity solar radiation. It does well on moist, generally open, sites, with northern exposures, but needs at least partial canopy coverage where the aspect is southern or western</p> <p>Rock gnome lichen is known from the Southern Appalachian</p>	The proposed dicamba DGA uses are not expected to overlap with high elevation vertical rock faces where the species occurs.	http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html

Species	Habitat	Rationale	Source
	Mountains of North Carolina and South Carolina, Tennessee, and Georgia, in areas of high humidity, either at high elevations, where it is frequently bathed in fog, or in deep gorges at lower elevations.		
Lyrate bladderpod (<i>Lesquerella lyrata</i>)	Limestone glades	Technical consultation with USFWS biologist indicated that this species will not occur in corn, soy, or cotton fields within the range	http://ecos.fws.gov/docs/recovery_plan/961017.pdf Email communication (Holbrook, S. (2015, June 17)).
Orchid, eastern prairie fringed (<i>Platanthera leucophaea</i>)	The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	The proposed dicamba DGA uses are not expected to overlap with grass or sedge-dominated plant communities.	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf

Species	Habitat	Rationale	Source
<u>Pogonia, small whorled (<i>Isotria medeoloides</i>)</u>	The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).	The proposed dicamba DGA uses are not expected to overlap with mixed deciduous/coniferous forests.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf
<u>Pondberry (<i>Lindera melissifolia</i>)</u>	Associated with seasonally flooded wetlands. Found on wet edges of sandy sinks, ponds, and swampy depressions. Shade tolerant (US FWS, 1993).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930923a.pdf

Species	Habitat	Rationale	Source
<u>Potato-bean, Price's (<i>Apios priceana</i>)</u>	Found in open forests along the edges of forests, creeks, and rivers (US FWS, 1993, p. executive summary).	The proposed dicamba DGA uses are not expected to overlap with forests, or water bodies.	USFWS. 1993. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930210.pdf
<u>Prairie-clover, leafy (<i>Dalea foliosa</i>)</u>	Leafy prairie-clover is found only in open limestone cedar glades, limestone barrens, and dolomite prairies which have shallow, silt to silty clay loam soils over flat and often highly fractured, horizontally bedded limestone or dolomite with frequent expanses of exposed bedrock at surface. Elevations are typically between 550 and 700 feet. These habitats experience high surface and soil temperatures, generally have low soil moisture but are wet in the spring and fall and become droughty in summer. The distribution of glade, barren, and dry to wet dolomite prairie at any particular site varies and leads to a mosaic of soils and their associated plant communities (USFWS, 1996, p.13).	The proposed dicamba DGA uses are not expected to overlap with prairies or areas with visible bedrock.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919b.pdf
<u>Quillwort, Louisiana (<i>Isoetes louisianensis</i>)</u>	This species grows in sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland. bayhead forests of fine flatwoods and upland longleaf pine (USFWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with streams, overflow channels, or riparian woodlands.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960930b.pdf

Species	Habitat	Rationale	Source
<u>Rock-cress</u> <u>Braun's (<i>Arabis</i></u> <u><i>perstellata</i>)</u>	Braun's rockcress occurs on the slopes of calcareous mesophytic and sub-xeric forest types. The occurrence of this species does not appear to be limited to a particular slope aspect, elevation, or moisture regime within the slope forests. It is, however, sun intolerant and always occurs in at least partial shade. The largest and most vigorous populations occur on moist mid- to upper slope sites. Plants are often found around rock outcrops, protected sites on the downslope side of tree bases, and sites of natural disturbance, such as talus slopes and animal trails. It is rarely found growing among the Leaf litter and herbaceous cover of the forest floor (US FWS, 1997).	The proposed dicamba DGA uses are not expected to overlap with calcareous mesophytic and sub-xeric forested systems.	USFWS. 1997. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970722.pdf
<u>Rosemary</u> <u>Cumberland</u> <u>(<i>Conradina</i></u> <u><i>verticillata</i>)</u>	This species is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to	The proposed dicamba DGA uses are not expected to overlap with rivers.	USFWS. 2011. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3629.pdf

Species	Habitat	Rationale	Source
	maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (pg. 8) (US FWS, 2011).		
<u>Sandwort, Cumberland</u> (<u>Arenaria cumberlandensis</u>)	This species is restricted to sandstone rock houses, ledges, and solution pockets on sandstone rock faces; The species is found on the sandy floors of rock houses, in solution pockets on the face of sandstone cliffs, and on ledges beneath overhanging sandstone (pg. 4) (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with sandstone rock houses, ledges, or rock faces.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960620.pdf
<u>Skullcap, large-flowered</u> (<u>Scutellaria montana</u>)	This species occurs in slope, ravine, and stream-bottom forests in northwestern Georgia and adjacent southeastern Tennessee. Habitat loss and lack of information on appropriate management are the factors limiting the number of viable populations (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with ravine and stream-bottom forests.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960515.pdf
<u>Spiraea, Virginia</u> (<u>Spiraea virginiana</u>)	<i>Spiraea virginiana</i> is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf

Species	Habitat	Rationale	Source
	near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-18.).		
<u>Sunflower, whorled</u> (<u>Helianthus verticillatus</u>)	This species occurs in remnant prairie habitats found in uplands and swales of headwater streams in the Coosa River watershed in Georgia and Alabama and in the East Fork Forked Deer and Tuscumbia Rivers' watersheds in Tennessee. (US FWS 2014, p. 50993)	The proposed dicamba DGA uses are not expected to overlap with prairie habitats.	USFWS. 2014. Federal Register: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2014-08-26/pdf/2014-19558.pdf
<u>Thistle, Pitcher's</u> (<u>Cirsium pitcheri</u>)	It occurs on non-forested sand dunes of several types (grassland dunes, simple linear beach foredunes, continuous and discontinuous dune complexes), sand beaches, and sandy blowouts, primarily occurring around the Great Lakes (US FWS, 2002, p. 23-27).	The proposed dicamba DGA uses are not expected to overlap with sand dunes, sand beaches, or sandy blowouts.	USFWS. 2002. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020920b.pdf
<u>Alabama canebrake pitcher-plant</u> (<u>Sarracenia rubra alabamensis</u>)	Occurs in sandhill seeps, swamps, and bogs along the fall-line of central Alabama. Colony sites are wet much of the year and are often characterized as wet bogs or wet	The proposed dicamba DGA uses are not expected to overlap with seeps, swamps or bogs.	1992 USFWS Recovery Plan: Alabama Canebrake Pitcher Plant 2012 USFWS Alabama Canebrake Pitcher-Plant (<i>Sarracenia rubra</i> ssp. <i>alabamensis</i>)

Species	Habitat	Rationale	Source
	flatwoods. Within this general habitat type, colony health seems to be a function of unaltered hydrology and maintenance of an early successional stage in which competing woody vegetation is limited. Naturally occurring fires and hydrological conditions control the pioneering of woody species on these sites (USFWS 1992)		5-Year Review: Summary and Evaluation
<u>Alabama leather flower</u> (<i>Clematis socialis</i>)	Occurs in mesic flats, specifically in right-of-ways, bush-hogged areas, forests that have been selectively logged (USFWS 1989) Open grass-seed-rush prairie areas and adjoining hardwood swamp forests (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with mesic flats or forests.	1989 USFWS Alabama leather flower recovery plan 2010 USFWS Alabama leather flower 5-year review
<u>Alabama streak-sorus fern</u> (<i>Thelypteris pilosa</i> var. <i>alabamensis</i>)	All known Alabama occurrences of the Alabama streak-sorus fern are found on Pottsville sandstone, where plants grow in crevices and rough surfaces on the roofs and floors of sandstone rockhouses formed along these cliffs (Watkins and Farrar 2002). The plants typically occur on moist, shady sites such as ceilings of rockhouses, ledges beneath sandstone overhangs, and on exposed cliff faces	The proposed dicamba DGA uses are not expected to overlap with sandstone rockhouses.	2014 USFWS Alabama streak-sorus fern (<i>Thelypteris burksiorum</i>) 5-year Review: Summary and Evaluation. Page 7. Available at: http://ecos.fws.gov/docs/five_year_review/doc4363.pdf

Species	Habitat	Rationale	Source
	(USFWS 1996). Locations vary in slope aspect and shade coverage, from completely shaded to partially sunny on exposed bluff faces. Sites are usually directly above or a short distance from the river, are shaded to partially sunny, and have substrates that are kept moist by water vapor from the river and up-slope runoff over the sandstone (USFWS 1996). (USFWS 2014)		
<u>Ashy dogweed</u> <u>(<i>Thymophylla</i></u> <u><i>tephroleuca</i>)</u>	Occurs in the ceniza-blackbrush-creosotebush brush community in the South Texas Plains vegetation area; however, this site may have originally been grassland. Noted to grow in open areas on fine-sandy loam, however the only known population occurs on Maverick-Caterina soil association, which is clayey, saline, deep to shallow, fine textured, and slowly permeable. Underlying geology is the Laredo Formation, composed of Eocene sandstones and clays. The habitat probably once supported a greater diversity of plants, but dominant plants now are buffelgrass (<i>Cenchrus ciliaris</i>), mequite (<i>Prosopis glandulosa</i>), goatbush (<i>Castela</i>	The proposed dicamba DGA uses are not expected to overlap with plains.	1987 USFWS Ashy Dogweed (<i>Thymophylla tephroleuca</i>) Recovery Plan

Species	Habitat	Rationale	Source
	<i>texana</i>), Cenizo (<i>Leucophyllum frutescens</i>), anacahuita (<i>Cordia boissieri</i>), yucca (<i>yucca spp</i>), and javelina brush (<i>Microrhamnus ericoides</i>) (USFWS 1987)		
<u>Black lace cactus</u> (<i>Echinocereus reichenbachii</i> var. <i>albertii</i>)	This species is found in the vicinity of dense brush, but grows in mostly open, unshaded areas (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with areas of dense brush.	2009 USFWS Black Lace Cactus (<i>Echinocereus reichenbachii</i> var. <i>albertii</i>) 5-year Review: Summary and Evaluation
<u>Black spored quillwort</u> (<i>Isoetes melanospora</i>)	Black-spored quillwort is restricted to shallow, flat bottomed depressions on granitic outcrops in the piedmont region of Georgia. Depressions are entirely rock rimmed and generally occur near the summit, with most water accumulating from direct rainfall and little flowing water to provide nutrient input. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2008 USFWS Granite Outcrop Plants 5-year Review. Page 8. Available at: http://ecos.fws.gov/docs/five_year_review/doc1987.pdf
<u>Bunched arrowhead</u> (<i>Sagittaria fasciculata</i>)	Obligate wetland species. Saturated to flooded soils. Undisturbed sites are typically located just below the origin of slow, continuous seeps on gently sloping terrain in deciduous woodlands (USFWS 1983)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1983 USFWS Bunched Arrowhead Recovery Plan.
<u>Bunched cory cactus</u> (<i>Coryphantha ramillosa</i>)	The species grows on limestone in xerophyllous scrub and in the desert on bare rock, talus, or scree. <i>Coryphantha ramillosa</i> also grows in	The proposed dicamba DGA uses are not expected to overlap with desert.	1989 USFWS Bunched Cory Cactus (<i>Cory Dhantha ramillosa</i>) Recovery Plan

Species	Habitat	Rationale	Source
	Chihuahuan Desert succulent scrub on rocky slopes, ledges, and gravelly flats on Santa Elena or Boquillas limestones (USFWS 1989)		
<u>Canby's dropwort</u> (<i>Oxypolis canbyi</i>)	Coastal plains - specifically in pond cypress savannas, the shallows and edges of cypress pond/pine sloughs, and wet pine savannas. These are shallowly flooded, open habitats. Found in natural ponds dominated by cypress, grass-sedge dominated Carolina bays. (USFWS 1990) Wetlands (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1990 USFWS Canby's dropwort recovery plan 2010 USFWS Canby's dropwort 5-year review
<u>Chisos Mountain hedgehog Cactus</u> (<i>Echinocereus chisoensis</i> var. <i>chisoensis</i>)	Alluvial flats with Chihuahuan desert scrub vegetation (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with deserts.	1993 USFWS Chisos Mountain hedgehog cactus recovery plan
<u>Cooley's meadowrue</u> (<i>Thalictrum cooleyi</i>)	Grassland/herbaceous, woody wetland, and herbaceous wetlands (p. i). (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1994 USFWS Recovery Plan
<u>Davis' green pitaya</u> (<i>Echinocereus viridiflorus</i> var. <i>davisii</i>)	Chihuahuan desert in a semi-arid grassland. (USFWS 1984) Outcrops of Caballos Novaculite Formation; found in cracks and crevices. (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with desert.	1984 USFWS 5-Year Reviews of 23 Southwestern Species 2012 USFWS Davis' green pitaya and Nellie's cory cactus 5-year review

Species	Habitat	Rationale	Source
<u>Dwarf-flowered heartleaf</u> (<i>Hexastylis naniflora</i>)	Along bluffs and north-facing slopes, boggy areas along streams, and adjacent hillsides and ravines with acid, sandy loam soils in deciduous forests	The proposed dicamba DGA uses are not expected to overlap with wetlands or bluffs.	USFWS NC State Herbarium Fact Sheet - Dwarf-flowered heartleaf
<u>Florida torreyia</u> (<i>Torreya taxifolia</i>)	The Florida torreyia is a dioecious coniferous tree found in the slope forest (FNAI 2010) that cover hammocks, steep, deeply shaded limestone slopes and wooded ravines along the east side of the Apalachicola River in Florida (Fig. 1), and adjacent Lake Seminole in Georgia. Soils in these areas are within the orders Alfisols and Mollisols. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with forests.	USFWS 2010. <i>Torreya taxifolia</i> (Florida torreyia) 5-Year Review. Page 13. Available at: http://ecos.fws.gov/docs/five_year_review/doc3258.pdf
<u>Fringed campion</u> (<i>Silene polypetala</i>)	Occurs in hardwood forests in bottomland and ravines. It is often on fairly steep slopes of deep ravines or north-facing hillsides, sometimes on nearly level ground, particularly in flatwoods developed on Iredell soils. Occurs mainly in small isolated patches of rich hardwood. The great majority of populations occur in the watershed of the Apalachicola River and its tributary, the Flint River. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with forests.	1996 USFWS Technical Agency Draft Recovery Plan for Fringed Campion (<i>Salene polypetula</i>) USFWS Species Profile: Fringed campion (<i>Silene polypetala</i>) (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q21P)

Species	Habitat	Rationale	Source
<u>Gentian pinkroot</u> (<i>Spigelia gentianoides</i>)	Well drained upland pinelands; longleaf pine-wiregrass ecosystem (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with forests.	2012 US FWS Gentian pinkroot 5-Year Review
<u>Golden sedge</u> (<i>Carex lutea</i>)	The land surface is characterized by large areas of broad, level flatlands and shallow stream basins. Golden sedge grows in sandy soils overlying coquina limestone deposits, where the soil pH is unusually high for this region, typically between 5.5 and 7.2. Soils supporting the species are very wet to periodically shallowly inundated. The species prefers the ecotone (narrow transition zone between two diverse ecological communities) between the pine savanna and adjacent wet hardwood or hardwood/conifer forest. Most plants occur in the partially shaded savanna/swamp where occasional to frequent fires favor an herbaceous ground layer and suppress shrub dominance. Other species with which this sedge grows include tulip poplar (<i>Liriodendron tulipifera</i>), pond cypress (<i>Taxodium ascendens</i>), red maple (<i>Acer rubrum</i> var. <i>trilobum</i>), wax myrtle (<i>Myrica cerifera</i> var. <i>aspera</i>).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2009 USFWS Golden Sedge (<i>Carex lutea</i>) Five-Year Review: Summary and Evaluation

Species	Habitat	Rationale	Source
	<p><i>cerifera</i>), colic root (<i>Aletris farinosa</i>), and several species of beakrush (<i>Rhynchospora spp.</i>).</p> <p>At most sites, golden sedge shares its habitat with Cooley's meadowrue (<i>Thalictrum cooleyi</i>), another federally endangered plant species, and with Thorne's beakrush (<i>Rhynchospora thornei</i>), a species of concern to us. (USFWS 2009)</p>		
<p><u>Bat, gray</u> (<u>Myotis</u> <u>grisescens</u>)</p>	<p>Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when</p>	<p>The proposed dicamba DGA uses are not expected to encompass caves or the forest/open water areas where bats forage.</p>	<p>USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf</p> <p>USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf</p>

Species	Habitat	Rationale	Source
	migrating (US FWS, 1982. pp. 6-7).		
<u>Green pitcher-plant</u> <u>(<i>Sarracenia oreophila</i>)</u>	Habitats can be generally grouped into two types: stream banks (considered ephemeral) and upland bogs. Upland bogs, fire dependent, range from open to forested, underlain by semi-impervious clay layers (USFWS 2013)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2013 US FWS Green pitcher plant (<i>Sarracenia oreophila</i>) 5-Year Review: Summary and Evaluation
<u>Hairy rattleweed</u> <u>(<i>Baptisia arachnifera</i>)</u>	22 extant populations occur entirely in Lower Coastal Plain of Georgia, 125 square miles over northern Brantley County and southeastern corner of Wayne County. Longleaf slash-pine flatwoods with sparse canopy, fewer larger shrubs, greater light penetration and greater cover of herbs (mainly wiregrass) and low shrubs of the Lower Coastal Plain of Georgia. Early successional characteristics of open canopy and low abundance of larger shrubs. Mesic pine lowland forest or pine flatwoods. Also occurs in floristically similar but more open pine-wire grass (<i>Aristida stricta</i>) shrub woodlands with occasional oaks	The proposed dicamba DGA uses are not expected to overlap with the margins of cultivated land.	2011 USFWS Hairy Rattleweed (<i>Baptisia arachnifera</i>) 5-Year Review: Summary and Evaluation 1984 USFWS Recovery Plan for Hairy Rattleweed (<i>Baptisia arachnifera</i>)

Species	Habitat	Rationale	Source
	<p>(<i>Quercus laevis</i>, <i>Q. virginiana</i>, <i>Q. nigra</i>). Fire adapted communities that would naturally burn every 2-4 years. Most abundant in communities with the early successional characteristics of open canopy and low abundance of larger shrubs. Presently occurs in slash-pine plantations within its range, also along highway/utility/logging road ROWs and some natural communities (longleaf pine-wiregrass-shrub communities), and margins of cultivated land (generally corn, tobacco, and pasture). Level to gently sloping land. Often adjacent to/grades into pocosin or bay swamp habitats scrub-shrub wetlands toward the wetter end of spectrum to habitats typical of longleaf pine-turkey oak communities towards the drier end. (USFWS 2011)</p>		
<u>Heller's blazingstar</u> (<i>Liatris helleri</i>)	Heller's blazing star habitat consists of rock outcrops, ledges, cliffs, and balds at high elevations (USFWS 1989)	The proposed dicamba DGA uses are not expected to overlap with rock outcrops or cliffs.	1989 USFWS Recovery Plan for <i>Liatris helleri</i> (Heller's Blazing Star)
<u>Hinckley oak</u> (<i>Quercus hinckleyi</i>)	<i>Quercus hinckleyi</i> occurs in an arid subtropical climate. Climatologists place it in the Trans-Pecos climatic area of Texas, which is extremely	The proposed dicamba DGA uses are not expected to overlap with forests.	1991 USFWS Hinckley Oak (<i>Quercus hinckleyi</i>) 5-Year Review: Summary and Evaluation

Species	Habitat	Rationale	Source
	variable because of topographic differences. The area generally has great daily temperature fluctuations and an arid profile where evaporation exceeds precipitation. The average temperature is approximately 30.40°C (86.80°F), with an average precipitation of 23.4 cm (9.2 inches) (USFWS 1991)		
<u>Houghton's goldenrod</u> (<i>Solidago houghtonii</i>)	This plant grows on the shores of the Great Lakes, mainly Lake Huron and Lake Michigan, at the Michigan-Ontario border. (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with shores.	2011 US FWS Houghton's Goldenrod (<i>Solidago houghtonii</i> A. Gray, Asteraceae) 5-Year Review: Summary and Evaluation
<u>Johnston's frankenia</u> (<i>Frankenia johnstonii</i>)	Open or sparsely vegetated rocky gypsum hillsides or saline flats. In Texas, occur in mesquite blackbrush community (USFWS 1988)	The proposed dicamba DGA uses are not expected to overlap with saline flats.	1988 USFWS Johnston's Frankenia (<i>Frankenia johnstonii</i>) Recovery Plan 2003 USFWS Endangered and Threatened Wildlife and Plants; Delisting the plant Frankenia johnstonii (<i>Johnston's frankenia</i>) and Notice of Petition Finding.68 FR 27961
<u>Kentucky glade cress</u> (<i>Leavenworthia exigua laciniata</i>)	<i>Leavenworthia exigua</i> var. <i>laciniata</i> is typically found in cedar or limestone glades (Baskin and Baskin 1981, p. 243), which are described by Baskin and Baskin (1999, p. 206) as “open areas of rock pavement, gravel, flagstone, and/or shallow soil in which occur natural, long-persisting (edaphic climax) plant	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2014. Designation of Critical Habitat for <i>Leavenworthia exigua</i> var. <i>laciniata</i> (Kentucky Glade Cress); Final rule. Page 25691. Available at: http://www.gpo.gov/fdsys/pkg/FR-2014-05-06/pdf/2014-10050.pdf

Species	Habitat	Rationale	Source
	<p>communities dominated by angiosperms and/or cryptogams.”</p> <p><i>L. exigua</i> var. <i>laciniata</i> is also known from gladelike areas such as overgrazed pastures, eroded shallow soil areas with exposed bedrock, and areas where the soil has been scraped off the underlying bedrock (Evans and Hannan 1990, p. 8). These disturbed areas are gladelike in the shallowness or near-absence of their soils, saturation, and/or inundation during the wet periods of late fall, winter, and early spring and then frequently dry below the permanent wilting point during the summer (Baskin and Baskin 2003, p. 101). (USFWS 2014, p25691)</p>		
<u>Kral's water-plantain</u> <u>(<i>Sagittaria secundifolia</i>)</u>	<p>This taxon typically occurs on frequently exposed shoals or rooted among loose boulders in quiet pools up to 1 meter (3.3 feet) in depth. The plant is found in the Little River drainage in Dekalb and Cherokee counties, the Town Creek drainage in Dekalb County, and in the West Sipsey Fork in Winston County in Alabama. (USFWS 1991)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with water bodies.</p>	<p>1991 USFWS Kral's Water-Plantain (<i>Sagittaria secundifolia</i>) Recovery Plan</p>

Species	Habitat	Rationale	Source
<u>Large-fruited sand-verbena</u> (<i>Abronia macrocarpa</i>)	Post oak savanna region of eastern Texas. Documented wild populations occur in acid, relatively infertile sandy soils of the Arenosa, Silstead-Padina, Pickton, and Wolfpen series lie 79-127 cm deep over sandy clay loam. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with post oak savanna.	2010 USFWS 5-year review Large-fruited Sand-verbena (<i>Abronia macrocarpa galloway</i>)
<u>Little Aguja (=Creek) Pondweed</u> (<i>Potamogeton clystocarpus</i>)	Grows in alluvial substrates of shallow, protected area of Little Aguja Creek. Species located in pools along the streambed. Flash floods and drought are part of the normal stream ecology (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with alluvial areas around creeks.	1994 USFWS Little Aguja pondweed recovery plan (<i>Potamogeton clystocarpus</i>).
<u>Little amphianthus</u> (<i>Amphianthus pusillus</i>)	On granitic outcrops in the Piedmont physiographic region of the southeastern United States generally in eroded depressions or, rarely, quarry pools fanned on flat- to doming granite outcrops. Occur in shallow flat-bottomed pools on the crest or flattened slopes of unquarried outcrops. Pools might be several meters in diameter. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with granitic outcrops.	2008 USFWS Granite Outcrop Plants 5-year Review
<u>Lloyd's Mariposa cactus</u> (<i>Echinomastus mariposensis</i>)	Hills and lower slopes of mesas. Occur in full sun on patches of limestone chips. Chihuahuan desert scrub community. (USFWS 1990)	The proposed dicamba DGA uses are not expected to overlap with desert.	1990 USFWS Lloyd's Mariposa Cactus (<i>Neolloydia mariposensis</i>) Recovery Plan U.S. Fish and Wildlife Service Albuquerque, New Mexico

Species	Habitat	Rationale	Source
<u>Mat-forming quillwort</u> (<i>Isoetes tegetiformans</i>)	Mat-forming quillwort is restricted to shallow, flat bottomed depressions on granitic outcrops in the piedmont region of Georgia. Depressions are entirely rock rimmed and generally occur near the summit, with most water accumulating from direct rainfall and little flowing water to provide nutrient input. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with depressions on granitic outcrops.	2008 USFWS Granite Outcrop Plants 5-year Review. Page 8. Available at: http://ecos.fws.gov/docs/five_year_review/doc1987.pdf
<u>Miccosukee gooseberry</u> (<i>Ribes echinellum</i>)	Mixed mesophytic hardwoods (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with forests.	2008 US FWS Miccosukee Gooseberry 5-Year Review
<u>Michaux's sumac</u> (<i>Rhus michauxii</i>)	It is endemic to the inner coastal plain and piedmont of the Carolinas, Georgia, and Florida, where it occupies sandy or rocky open woods. It appears to depend upon some form of disturbance to maintain the open quality of its habitat. (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with sandy or rocky open woods.	1993 USFWS RECOVERY PLAN for Michaux's Sumac (<i>Rhus michauxii</i>) Sargent
<u>Michigan monkey-flower</u> (<i>Mimulus michiganensis</i>)	Aquatic to semi-aquatic habitat. It is restricted to cold, alkaline spring seepages and streams, usually in association with northern white cedar (<i>Thuja occidentalis</i>) swamps formed in drainages found at the base of relatively steep, morainic slopes and bluff. Within its habitat, it generally flourishes	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2011 USFWS Michigan Monkey-flower (<i>Mimulus michiganensis</i>) 5-Year Review: Summary and Evaluation 1997 USFWS Recovery Plan for Michigan Monkey-flower (<i>Mimulus glabratus</i> var. <i>michiganensis</i>)

Species	Habitat	Rationale	Source
	<p>best in tree canopy openings, along forest edges, or along streams adjacent to open, meadow-like areas and flowers abundantly when growing in full sunlight. However, it mostly persists as sterile colonies when growing under heavy tree canopy cover. (USFWS 2011)</p> <p>Surveys of some locations found water temperature ranging from 8.7 to 16.6° C, pH ranging from 7.66-8.4, conductivity ranging from 190 to more than 300 umhos and high concentrations of ammonium, nitrate, and phosphorus. (USFWS 1997)</p>		
<u>Mohr's Barbara button</u> <i>(Marshallia mohrii)</i>	<i>Marshallia mohrii</i> typically occurs in moist, prairie-like openings in woodlands and along shale-bedded streams. (USFWS 1991)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1991 USFWS RECOVERY PLAN for Mohr's Barbara's buttons <i>Marshallia mohrii</i> Beadle & F.E. Boynton
<u>Mountain golden heather</u> <i>(Hudsonia montana)</i>	<p>Fire maintained, keeps woody trees and shrubs down. (USFWS 2012)</p> <p>Limited to chillhowee quartzite ledges and outcrops found along Linville Gorge. In watershed of the Linville River. Ledge habitats exposed to direct sunlight. Edaphically maintained ecotone between bare rock and</p>	The proposed dicamba DGA uses are not expected to overlap with outcrops and ledges.	<p>2012 USFWS Mountain Golden Heather (<i>Hudsonia montana</i>) 5-Year Review: Summary and Evaluation</p> <p>1983 USFWS Mountain Golden Heather (<i>Hudsonia montana</i>) Recovery Plan</p>

Species	Habitat	Rationale	Source
	pine/ericaceous shrub community, with mtn golden heather local dominant in the ecotone. (USFWS 1983)		
<u>Mountain sweet pitcher-plant</u> <u>(<i>Sarracenia rubra</i> ssp. <i>jonesii</i>)</u>	It is found in the wetter parts of boggy areas in the coastal plain from southern Georgia and northern Florida to southern Mississippi. Quite often the plants can be found near the waterline. They may occasionally be submerged. While submerged, it will capture water arthropods and tadpoles. (USFWS 2013)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	2013 USFWS Mountain sweet pitcher plant (<i>Sarracenia rubra</i> ssp. <i>jonesii</i>) 5-Year Review: Summary and Evaluation
Morefield's leather flower (<i>Clematis morefieldii</i>)	It occurs in patches near seeps and springs in rocky limestone woods, typically at elevations of 800 to 11 feet, on the south and wouthwest facing slopes of mountains in open to dense juniper-hardwoods communities	The proposed DGA uses are not expected to overlap with rocky limestone wood habitat on mountains.	1994 USFWS. Recovery Plan for Morefield's leather flower (<i>Clematis morefieldii</i>). Atlanta, Georgia. 15 pp. http://ecos.fws.gov/docs/recovery_plan/940503.pdf
<u>Navasota ladies'-tresses</u> <u>(<i>Spiranthes parksii</i>)</u>	Clearly associated with the Post Oak Savanna vegetation type of east-central Texas. Highest numbers of individuals found in lightly wooded, lightly grazed stream banks of minor tributaries associated with the Navosta and Brazos drainages (2, p.10-11). Oak Savanna associates – <i>Quercus stellata</i> , <i>Q. nigra</i> , <i>Q. marilandica</i> , <i>Ulmus</i>	The proposed dicamba DGA uses are not expected to overlap with savanna.	1984 USFWS Navasota Ladies'-tresses (<i>Spiranthes parksii</i>) Recovery Plan

Species	Habitat	Rationale	Source
	<i>alata</i> , <i>Celtis laevigata</i> , <i>Ilex vomitoria</i> , <i>Forestiera ligustrina</i> , <i>Callicarpa americana</i> , <i>Ascyrum hypericoides</i> , <i>Stillingria sylvatica</i> , and numerous herbs (USFWS 1984)		
<u>Neches River rose-mallow</u> (<u><i>Hibiscus</i> <i>dasycalyx</i></u>)	Intermittent or perennial wetlands within the Neches, Sabine, and Angelina River floodplains or Mud and Tantabogue Creek basins that contain: (a) Hydric alluvial soils and the potential for flowing water when found in depressional sloughs, oxbows, terraces, side channels, or sand bars; (b) Native woody or associated herbaceous vegetation, largely with an open canopy providing partial to full sun exposure with low levels or no nonnative species.	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2013. Designation of Critical Habitat for Texas Golden Glade cress and Neches River Rose-Mallow; Final Rule. Page 56093. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-09-11/pdf/2013-22083.pdf
<u>Nellie cory cactus</u> (<u><i>Coryphantha</i> <i>minima</i></u>)	Desert grassland. Restricted to the Caballos Naviculite Formation, a quartz formation that forms low-lying ridges that are highly resistant to erosion. The Nellie Cory cactus is usually found growing among the chips of weathered and physically fractured novaculite, often associated with spikemoss (<i>Selaginella</i> <i>sp.</i>). The plants follow the cracks in the	The proposed dicamba DGA uses are not expected to overlap with desert grassland.	1984 USFWS Recovery Plan for the Nellie Cory Cactus 2012 USFWS Davis's Green Pitaya <i>Echinocereus viridiflorus</i> <i>var. davisii</i> Houghton and Nellie Cory Cactus <i>Escobaria minima</i> (Baird) D.R. Hunt (Syn. <i>Coryphantha minima</i> Baird) Five Year Review

Species	Habitat	Rationale	Source
	<p>formation (USFWS 1984)</p> <p>Has a very clumped distribution, caespitose, plants not evenly distributed. (USFWS 2012)</p>		
<u>Pecos (=puzzle, =paradox) sunflower</u> <u>(<i>Helianthus paradoxus</i>)</u>	<p>Pecos sunflower is a wetland plant that grows on wet, alkaline soils at spring seeps, wet meadows, stream courses and pond margins. It has seven widely spaced populations in west-central and eastern New Mexico and adjacent Trans-Pecos Texas. These populations are all dependent upon wetlands from natural groundwater deposits. Incompatible land uses, habitat degradation and loss, and groundwater withdrawals are historic and current threats to the survival of Pecos sunflower. (USFWS 2005)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with wetlands.</p>	<p>USFWS 2005 Final Pecos Sunflower Recovery Plan</p> <p>Available at: http://www.fws.gov/southwest/es/documents/r2es/pecos_sunflower_final_recovery_plan.pdf </p>
<u>Persistent trillium</u> <u>(<i>Trillium persistens</i>)</u>	<p>Found in deciduous or conifer deciduous forest of steep ravines and gorges, bouldered slopes; predominantly mesic slopes, but some dry exposed slopes. Wide variety of habitat conditions – noted to occur generally under a well developed overstory but also in open or closed canopies dominated by hemlock, hemlock-white pine, hemlock-beech, white</p>	<p>The proposed dicamba DGA uses are not expected to overlap with forests.</p>	<p>1984 USFWS Persistemt Trillium (<i>Trillim persistens</i>) Recovery Plan</p>

Species	Habitat	Rationale	Source
	pine, chestnut oak-white oak, black-oak-chestnut oak, with open or nearly closed shrub cover of Rhododendron minus, Rhododendron maximum, Leucothoe axillaris, and all combinations of the above, including with no shrubs or deciduous shrubs only. (USFWS 1984)		
<u>Relict trillium</u> (<i>Trillium reliquum</i>)	This species is typically found in mature and undisturbed hardwood stands. (USFWS 1991)	The proposed dicamba DGA uses are not expected to overlap with forests.	1991 USFWS Recovery Plan for Relict Trillium (<i>Trillium reliquum</i> Freeman)
<u>Rough-leaved loosestrife</u> (<i>Lysimachia asperulaefolia</i>)	Found in ecotone between longleaf pine or oak savannas and wetter shrubby plant communities. Coastal plains and sandhills. Requires moist, open habitat. Associated with 6 different community types: low pocosin, high pocosin, wet pine flatwoods, pine savanna, streamhead pocosin, and sandhill seep. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with longleaf pine or oak savannas.	1995 USFWS Rough-leaved loosestrife recovery plan
<u>Schweinitz's sunflower</u> (<i>Helianthus schweinitzii</i>)	Currently known from roadsides, power line clearings, old pastures, woodland openings, and other sunny to semi-sunny situations. Formerly, it probably occurred in prairie-like habitats or post oak-blackjack oak savannas maintained by fires set by lightning and Native	The proposed dicamba DGA uses are not expected to overlap with prairie-like habitats.	1994 USFWS Recovery Plan

Species	Habitat	Rationale	Source
	Americans (p. i). (USFWS 1994)		
<u>Seabeach amaranth</u> <i>(Amaranthus pumilus)</i>	Barrier island beaches of the Atlantic coast, inlets, temporary habitats, may move as areas become suitable or unsuitable habitat. Overwash flats at accreting ends of islands, lower foredunes and upper strands of noneroding beaches (landward of the wrackline). Does not occur on well-vegetated sites. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with beaches.	1996 Weakley, Bucher, Murdock U.S. Fish and Wildlife Service. 1996. Recovery Plan for Seabeach Amaranth. (<i>Amaranthuspumilus</i>) <i>Rafinesque</i>). Atlanta, Georgia. http://ecos.fws.gov/docs/recovery_plan/961112b.pdf . 2007 USFWS Seabeach Amaranth Five-Year Review; http://ecos.fws.gov/docs/five_year_review/doc1068.pdf
<u>Sensitive joint- vetch</u> <i>(Aeschynomene virginica)</i>	Occurs in fresh to slightly brackish tidal river systems, within the intertidal zone where populations are flooded twice daily. Typically occur in the estuarine meander zone of tidal rivers where sediments transported from upriver settle out and extensive marshes form. Need disturbed/open habitats such as: accreting point bars that have not yet been colonized by perennial species, low swales within extensive marshes, areas of nutrient deficiencies in saturated organic sediments, or areas of muskrat herbivory. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1995 USFWS Sensitive joint-vetch recovery plan 2012 USFWS Sensitive joint-vetch 5-year review

Species	Habitat	Rationale	Source
	Majority are found in natural tidal marsh habitats, but also a few documented cases of a pocket marsh wetland, edge of a moist soybean field, and a mowed grassy strip between a manmade drainage channel and dirt road. (USFWS 2012)		
Short's bladderpod (Physaria globosa)	Soils and outcrops of calcareous geologic formations along the mainstem or tributaries of the Kentucky and Cumberland rivers. The species inhabits these outcrops and soils where they occur on steeply sloped bluffs or hillsides. The combination of calcareous outcrops and shallow soils, steep slopes, and hot and dry conditions regulates the encroachment of herbaceous and woody species that exclude Short's bladderpod from vegetation communities present on more mesic sites.	The proposed dicamba DGA uses are not expected to occur in areas where calcareous outcrops, shallow soils, steep slopes and hot and dry conditions prevent the encroachment of herbaceous and woody species such as soybean and cotton.	2014. USFWS. Designation of Critical Habitat for Physaria globosa (Short's bladderpod), Helianthus verticillatus (whorled sunflower), and Leavenworthia crassa (fleshy-fruit gladeceess) Final Rule. Federal Register Federal Register Volume 79 Number 165 August 26, 2014 http://www.gpo.gov/fdsys/pkg/FR-2014-08-26/pdf/2014-19558.pdf
Short's goldenrod (Solidago shortii)	The habitat of Short's goldenrod is open areas in full sun or partial shade. Known occurrences are in limestone cedar glades, open eroded areas, edges, of open oak-hickory woods, cedar thickets, pastures, old fields, power line rights-of-way and rock ledges along rights-of-way. Cedar glades and	The proposed dicamba DGA salt uses are not expected to overlap with glades, woodland edges, pastures, or other habitat favorable for goldenrod growth.	1988 USFWS. Recovery Plan for Short's Goldenrod. U.S. Fish and Wildlife Service, Atlanta, Georgia. 27 pp. http://ecos.fws.gov/docs/recovery_plan/shortsgrodRP.pdf USFWS. 2007. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc1609.pdf

Species	Habitat	Rationale	Source
	woodland edges appear to be the natural habitat. Short's goldenrod was known historically and currently only from Kentucky when the Recovery Plan was written in 1988 (US FWS, pp. 3-4). An Indiana occurrence was located in 2001 along the Blue River in riparian habitat (US FWS, 2007, p. 6).		
Slender rush-pea (<i>Hoffmannseggia tenella</i>)	Occurs in patches of native short and mid-grass prairie (specifically associated with buffalograss, Texas wintergrass (<i>Stipa leucotrica</i>) and Texas grama (<i>Bouteloua rigidiset</i>) adjacent to watercourses, such as permanent or intermittent creeks. Restricted to the Texas Coastal Bend counties of Nueces and Kleberg. Eco-region is Gulf Prairies and Marshes biotic zone. Occurs on slopes (20 degrees max), along drainages, usually located in areas of short or sparse vegetation since it can't compete with taller grasses. Has been found on slopes close to mesquite-granjeno woodland areas and where shrubs are low. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with prairie.	2008 USFWS Slender Rush-pea (<i>Hoffmannseggia tenella</i>) 5 Year Review: Summary and Evaluation

Species	Habitat	Rationale	Source
<u>Small-anthered bittercress</u> (<i>Cardamine micranthera</i>)	<p>Native to small streambank seeps, adjacent sandbars, and stream edges in the Dan River drainage of the North Carolina and Virginia piedmont. (USFWS 1991)</p> <p>This plant occurs in moist and wet, shady areas near streams and in dim woodlands. Small-anthered bittercress is known only from the Dan River basin in north-central North Carolina (Stokes County) and south-central Virginia (Patrick County). (USFWS 1998)</p>	The proposed dicamba DGA uses are not expected to overlap with stream edges.	<p>1991 USFWS Recovery Plan for the Small-anthered bittercress <i>Cardamine micranthera</i></p> <p>1998 USFWS Recovery Plan for the <i>Cardamine micranthera</i></p>
<u>Smooth coneflower</u> (<i>Echinacea laevigata</i>)	The habitat of smooth coneflower consists of open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium- and calcium-rich soils associated with amphibolite, dolomite, or limestone (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with open woods, barrens, or bluffs.	2011 USFWS Smooth Coneflower (<i>Echinacea laevigata</i>) 5-Year Review: Summary and Evaluation
<u>Sneed pincushion cactus</u> (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)	The Sneed and Lee pincushion cacti grow in semi-desert grassland (Brown, 1982). The Sneed pincushion cactus is restricted to limestone and grows in cracks on vertical cliffs or ledges. The Sneed pincushion cactus grows at an elevation of 1,200-2,350 m in areas where the average	The proposed dicamba DGA uses are not expected to overlap with semi-desert grasslands.	1986 USFWS Recovery Plan for the Sneed and Lee Pincushion Cacti. Pages 8-9. Available at: http://ecos.fws.gov/docs/recovery_plan/860321b.pdf

Species	Habitat	Rationale	Source
	precipitation varies from 19.7 to 40 cm per year. Edaphic requirements are poorly understood. (USFWS 1986)		
<u>South Texas ambrosia</u> (<i>Ambrosia cheiranthifolia</i>)	Grows in the Gulf coastal grasslands of southern Texas. The plant is found in grassland and mesquite shrubland habitat on various soils. Associated with sites where native short-grass prairie species persist. Also on moderately disturbed sites such as cemeteries, right-of-ways, roadsides, parkfields, and eroded areas along creeks. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with grasslands.	2010 USFWS South Texas Ambrosia (<i>Ambrosia cheiranthifolia</i>) 5-Year Review: Summary and Evaluation
<u>Star cactus</u> (<i>Astrophytum asterias</i>)	Star cactus grows on sparsely vegetated areas in gravelly, saline clays or loams at low elevations in the Rio Grande Plains. (USFWS 2013) This species grows in grasslands and thorn shrub of the Rio Grande (US FWS 2003)	The proposed dicamba DGA uses are not expected to overlap with grasslands or thorn shrub.	USFWS 2013. Star Cactus (<i>Astrophytum asterias</i>) 5-Year Review: Summary and Evaluation Available at: http://www.fws.gov/southwest/es/Documents/R2ES/Star_Cactus_5-yr_Review_FINAL_June2013.pdf US FWS 2003. Recovery Plan. Available at: http://ecos.fws.gov/docs/recovery_plan/031106.pdf
<u>Swamp pink</u> (<i>Helonias bullata</i>)	Swamp pink is found in a variety of wetland habitats, including swampy forested wetlands bordering small streams; headwater wetlands; sphagnous, hummocky, dense Atlantic white cedar swamps; Blue Ridge swamps;	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1991 USFWS Swamp Pink (<i>Helonias bullata</i>) Recovery Plan Available at: http://ecos.fws.gov/docs/recovery_plan/910930c.pdf

Species	Habitat	Rationale	Source
	meadows; bogs; and spring seepage areas (USFWS 1991)		
<u>Terlingua Creek cat's-eye</u> <i>(Cryptantha crassipes)</i>	Grows on xeric, barren, gypsiferous, low rounded hills and gentle slopes composed of small platelets of stiltly limestone in the Trans-Pecos shrub savannah (p. iii). Obligate upland (p. iii). (USFWS 1994)	The proposed dicamba DGA uses are not expected to overlap with shrub savanna.	1994 USFWS Recovery Plan Available at: http://ecos.fws.gov/docs/recovery_plan/940405.pdf
<u>Texas ayenia</u> <i>(Ayenia limitaris)</i>	This species is associated with forest and scrubland of river flood plains and deltas in south Texas and northern Mexico. Occurs in open ground or under an open canopy, within or on the edges of thickets, on dry, alluvial clay soils. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with forests or scrubland.	2010 USFWS Texas Ayenia (Tamaulipan Kidney-petal), Ayenia limitaris Cristóbal, 5-Year Review Available at: http://ecos.fws.gov/docs/five_year_review/doc3241.pdf
<u>Texas Golden Gladecress</u> <i>(Leavenworthia texana)</i>	Open, sunny exposures of Weches outcrops within Weches glade plant communities that are characterized by the species listed in Table 1, with relatively thin, rocky soils that are classified within Nacogdoches, Trawick, or Bub soils mapping units as identified by the NRCS soil survey maps. There must be bare, exposed bedrock on top-level surfaces or rocky ledges with very shallow	The proposed dicamba DGA uses are not expected to overlap with Weches outcrops.	USFWS 2013. Designation of Critical Habitat for Texas Golden Gladecress and Neches River Rose-Mallow; Final Rule. Page 56087. Available at: http://www.gpo.gov/fdsys/pkg/FR-2013-09-11/pdf/2013-22083.pdf

Species	Habitat	Rationale	Source
	depressions where rainwater can pool or seepage can collect. (USFWS 2013)		
<u>Texas poppy-mallow</u> (<i>Callirhoe scabriuscula</i>)	Rolling Plains Vegetation zone of Texas. Deep, alluvial sands deposited in Runnels County, Texas (USFWS 1985)	The proposed dicamba DGA uses are not expected to overlap with the Rolling Plans.	1985 USFWS Texas poppy-mallow (<i>Callirhoe scabriuscula</i>): Recovery Plan
<u>Texas prairie dawn-flower</u> (<i>Hymenoxys texana</i>)	This plant grows only in the grasslands of the Gulf Coastal Plain in Texas. It can be found on open, barren stretches of saline sandy soil at the base of Mima mounds. (USFWS 1989)	The proposed dicamba DGA uses are not expected to overlap with grasslands.	1989 USFWS <i>Hymenoxys texana</i> Recovery Plan
<u>Texas snowbells</u> (<i>Styrax texanus</i>)	<p>Endemic to cliffs along rivers, streams, and dry creek beds in the Edwards Plateau. Grows in limestone crevices of creek and river bluffs. Elevations are 30m to 914 m. Shallow soils, wide range of textures. Lightly wooded vertical limestone and dolomite cliffs, mapped as Segovia and Fort Terrett members of the Edwards Limestone, the Devil's River Limestone, and the Glen Rose Formation. Numerous trees, shrubs, and herbs associated. (USFWS 1987)</p> <p>Moist habitats like river drainages, canyons, and draws, which are</p>	The proposed dicamba DGA uses are not expected to overlap with cliffs.	<p>1987 USFWS Texas Snowbells (<i>Styrax texana</i>) Recovery Plan</p> <p>2008 USFWS Texas Snowbells (<i>Styrax platanifolius</i> ssp. <i>Texanus</i>) 5-Year Review Summary and Evaluation</p>

Species	Habitat	Rationale	Source
	abundant in the Edwards Plateau. Surface water may not be present, but sites have subsurface water or collect runoff. Most plants are found where they get at least partial shade during the day from surrounding vegetation. Many occur on level terrain, but are most often described on vertical cliffs possibly because of herbivory on more accessible terrain. (USFWS 2008)		
<u>Texas trailing phlox (<i>Phlox nivalis</i> ssp. <i>texensis</i>)</u>	Sandy soils of open pine woodlands. Pineywoods vegetational area. May also be associated with the Gulf Prairies and Marshes vegetational areas, but this is not confirmed by historical or extant records. Plant prefers open canopy and at least some ground cover, and intermediate seral stages in community succession. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with pine woodlands.	1995 USFWS Texas trailing phlox recovery plan
<u>Texas wild-rice (<i>Zizania texana</i>)</u>	This plant grows in clear flowing spring-fed waters. (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with water bodies.	2008 USFWS 5-Year Reviews of 28 Southwestern Species
<u>Tobusch fishhook cactus (<i>Sclerocactus brevipalmatus</i> ssp. <i>tobuschii</i>)</u>	The cacti occur in gravelly soils along rivers and plants are periodically disturbed by flooding. Severe floods will destroy plants but some disturbance appears to benefit the species because non-flooded	The proposed dicamba DGA uses are not expected to overlap with streams, rivers or other water bodies.	USFWS 1987. Tobusch fishhook cactus recovery plan. Available at: http://ecos.fws.gov/docs/recovery_plan/870318a.pdf USFWS 2010. Tobusch Fishhook Cactus Completed 5-Year Review. Page 27. Available at:

Species	Habitat	Rationale	Source
	<p>areas become very grassy which tends to crowd out the cacti (USFWS 1987).</p> <p>However by the early 1990s many new locations had been discovered, and the species was known from eight counties. Most sites were no longer in the floodplain, but found from lower slopes to ridge tops (USFWS 2010)</p>		http://ecos.fws.gov/docs/five_year_review/doc3073.pdf
<u>Walker's manioc</u> <u>(<i>Manihot walkerae</i>)</u>	<p>An understory species that inhabits open brushlands in the Lower Rio Grande Valley of Texas and adjacent Mexico (p. i). Most manihot species are found in relatively dry regions, and only a few are typically found in rain forest regimes. Those species found in rain forest are typically found in openings in the forest... these considerations lead us to the hypothesis that most species are heliophiles capable of growth only when there is no shading, and that many of them are "weedy" types, capable of invasion into open areas (p. 6). (USFWS 2007)</p>	<p>The proposed dicamba DGA uses are not expected to overlap with open brushlands.</p>	<p>2007 USFWS Recovery Plan</p>
<u>White bladderpod</u> <u>(<i>Lesquerella pallida</i>)</u>	<p>The plant grows on openings in oak, hickory, and pine woods. It is limited to a part of the Piney Woods region on the Gulf</p>	<p>The proposed dicamba DGA uses are not expected to overlap with forests.</p>	<p>1992 USFWS White Bladderpod (<i>Lesquerella padilla</i>) recovery plan</p>

Species	Habitat	Rationale	Source
	Coastal Plain. (USFWS 1992)		
<u>White irisette</u> (<u>Sisyrinchium</u> <u>dichotomum</u>)	This rare herb is typically found in open dry to mesic oak-hickory forests on mid-elevation mountain slopes and on open, disturbed sites, such as woodland edges and roadsides. (USFWS 1995)	The proposed dicamba DGA uses are not expected to overlap with forests.	1995 US FWS RECOVERY PLAN for White Irisette (<i>Sisyrinchitan dichotomum</i>) Bicknell
<u>White-haired goldenrod</u> (<u>Solidago</u> <u>albopilosa</u>)	Grows in sandy soil behind the drip line of sandstone rock-shelters and on rock ledges. It is very rarely found in open sunlight and is never found in the darkest recesses of rock-shelters (p. i). (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with sandstone rock shelters.	1993 USFWS Recovery Plan
<u>Zapata bladderpod</u> (<u>Lesquerella</u> <u>thamnophila</u>)	Zapata bladderpod is known to occur on graveled to sandy-loam upland terraces above the Rio Grande flood plain. The known populations of Zapata bladderpod are associated with highly calcareous sandstones and clays, and occur within a community of shrub species. Zapata bladderpod occurs as an herbaceous component of an open <i>Leucophyllum frutescens</i> (cenizo) - <i>Acacia berlanderi</i> (guajillo) shrubland alliance (Nature Serve 2002) (Figure 4). Both	The proposed dicamba DGA uses are not expected to overlap with shrubland.	2004 USFWS Zapata Bladderpod (<i>Lesquerella thamnophila</i>) Recovery Plan

Species	Habitat	Rationale	Source
	plant communities dominate upland habitats on shallow soils near the Rio Grande (Diamond et al. 1987). These shrub lands are sparsely vegetated due to the shallow, fast-draining, highly erosional soils and semi-arid climate. (USFWS 2004)		

Appendix 3

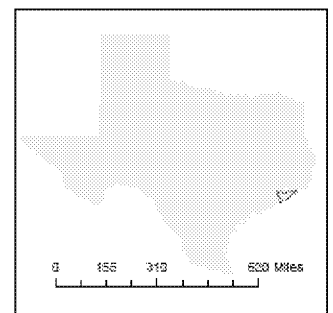
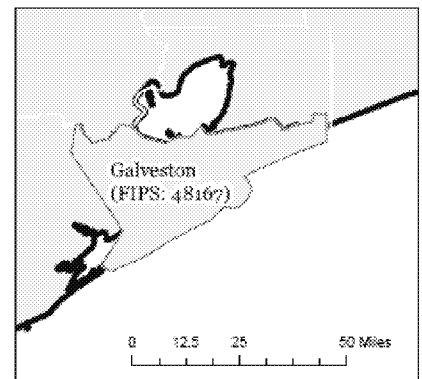
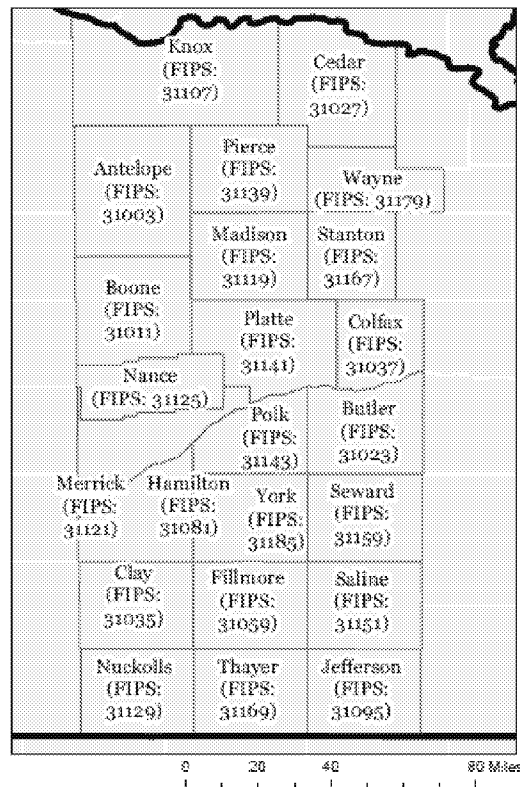
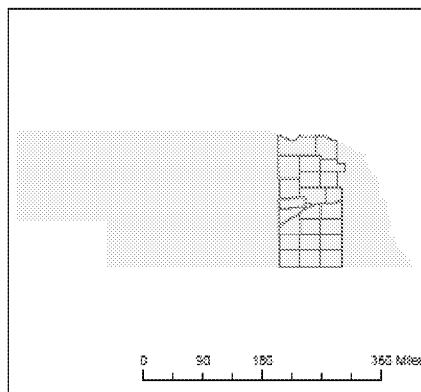
Input parameters for TIM simulation for calculating mortality to Eskimo curlew exposed to dicamba

Parameter	Value	Comments
pesticide name	dicamba	none
crop name	Corn, soybean and cotton	none
species name	Eskimo curlew	
Generic bird # (values of 1-30 are generic, 0 = custom)	0	
Passerine ? (yes=1, no = 0)	0	
nest type (0 =altricial, 1 = precocial)	1	
Number of birds (trials) simulated	10,000	
Flock size	50	Most recent estimate of population size
Random number seed (Enter 0 if user does not select a seed)	0	
Turns QC reports on (1) or off (0)	0	
Turns TIM executable call for user input on (1) or off (0)	0	
Turns MCnest outputs on (1) or off (0)	0	
Food switch	1	
Drinking water puddle switch	1	
Drinking water dew switch	1	
Inhalation vapor switch	0	The maximum vapor concentration at saturation (calculated by STIR) is 2.14e-3 mg/L. Since the available rat inhalation toxicity data did not establish an LC50 at a level that is orders of magnitude higher (i.e., 5.3 mg/L, MRID 00263861), this route of exposure is not considered of toxicological concern.
Inhalation spray switch	1	This is automatically turned off by the model due to the crop height.
Dermal contact switch	1	
Dermal spray switch	1	This is automatically turned off by the model due to the crop height.
Spray drift switch	0	Spray drift mitigations in place
Number of days simulated	3	Assume that while the birds are moving through the area during migration, they will stop and forage in an area for 3 d.
Number of applications	1	Assume that birds land in field on day of application
Rate of application #1 (lb a.i./A)	1.0	Proposed label
Interval between app1 and 2 (days)	0	

Parameter	Value	Comments
Rate of application #2 (lb a.i./A)	0	
Interval between app2 and 3 (days)	0	
Rate of application #3 (lb a.i./A)	0	
Interval between app3 and 4 (days)	0	
Rate of application #4 (lb a.i./A)	0	
Interval between app 4 and 5 (days)	0	
Rate of application #5 (lb a.i./A)	0	
Time of first application (hour)	8	Assume that application is made in the morning.
Application method (1 = Air, 2 = Ground Broadcast, 3 = Ground Banded, 4 = Ground infurrow, 5 = Airblast)	2	Proposed label
droplet spectrum for air and ground, (1= very fine to fine, 2 = fine to medium, 3 = medium to coarse (air only), 4 = coarse to very coarse (air only))	1	Since spray drift switch is turned off, this parameter value does not impact the model's results.
Spray height (m)	0.61	Assume 24" boom height.
Spray duration (min)	0.5	Default
Crop height (m)	0.127	Assumed height at time of 3 rd application (4 weeks after emergence).
Plant(crop) mass (kg/ha)	1	Default value. Not used because inhalation routes are turned off.
Crop type, (1= field, 2= orchard, 3= vineyard)	1	
Fraction of edge habitat receiving drift	0	
Fraction of organic carbon in soil	0.015	Default
Bulk density of soil (kg/L)	1.5	Default
Morning feeding start times: min and max	4 5	Default (Lebanon KS)
Morning feeding end times: min and max	6 10	
afternoon feeding start times: min and max	16 19	
afternoon feeding end times: min and max	20 21	
Proportion of daily feeding taking place in morning: min and max	0.4 0.6	Varying proportions of food distributed between morning and afternoon.
Gorging factor	3	Assume that birds gorge when they land. Factor of 3x normal feeding based on ECOFRAM recommendation.
Body weight (g): mean, sd, min, max	362, 36, 273, 454	Dunning 1984
feeding category: (1 = insectivore, 2 = herbivore, 3 = granivore, 4 = omnivore)	1	
Fraction of each food item: insects, seeds, fruit, grass, broadleaf	1.0, 0, 0, 0, 0	Recovery plan

Parameter	Value	Comments
For juveniles: fraction of each food item: insects, seeds, fruit, grass, broadleaf	1.0, 0, 0, 0, 0	Note that although there are juvenile parameters included here, these values are not the focus of this report. The juvenile parameters are used by the MCnest model.
Resident status (1=field, 0 = edge)	0	
Frequency on field: mean, min, max	0.1, 0, 1	Mean frequency on field of species is unknown. Mean values of 10% and 90% used to bound risk.
Fidelity factor (Q), (edge residents = 0.6, field residents = 0.8)	0.6	Default
Contaminated fraction of food	1.0, 1.0, 1.0, 1.0, 1.0	
Food item half-lives (days)	8.5 8.5 8.5 8.5 8.5	Foliar dissipation half-life used for all food items.
Aerobic soil metabolism half-life (days)	18	Aerobic soil metabolism half-life. Stable to hydrolysis.
Koc (L/kg-oc)	13.4	MRID 42774101
Kow	0.71	Based on LogD
Henry's law constant (atm/m ³ -mol)	1.17e-9	
Solubility in water (mg/L)	6100	SANDZONE Safety Data Sheet (Nov 1989)
Dislodgable foliar residue adjustment factor	0.48	default
Dermal adsorption fraction	1	default
avian acute oral LD50 (mg a.i./kg-bw)	188	From bobwhite quail study.
Slope of avian oral LD50	4.5	No value is available. Assume default.
Avian acute inhalation LD50 (mg a.i./kg-bw)	0	Not available.
Rat inhalation LD50 (mg a.i./kg-bw)	≥594	Value converted from LC50 value. (MRID 00263861)
Rat acute oral LD50 (mg a.i./kg-bw)	2740	MRID 00078444
Respiratory physiology adjustment factor	3.2	Default for bird body weight.
Chemical specific avian dermal LD50 (enter 0 if no value is available)	0	None
Food matrix adjustment factor	1	No data are available. Assume default.
Fraction of pesticide retained from one hour to the next	0.99	MRID 43245202
ratio of juvenile to adult toxicity	1	No data are available. Assume default.

Appendix 4
Bird Species County Land cover Information
Eskimo Curlew



	Corn	Cotton	Rice	Soybean	Wheat	Vegetable/ ground fruit	Orchards/ grapes	Other grains	Other Row crops	Other crops	Pasture/ hay/ forage
Full County Range	12,971,726	0	5,016	7,312,078	560,712	21,885	582	261,925	2,495	10,263	1,270,357
n=24											
Texas (n=1)	0	0	5,016	103	232	18	492	2820	0	0	16,625
Nebraska (n=23)	12,971,726	0	0	7,311,975	560,480	21,867	90	259,105	2,495	10263	1253732

Appendix 5
Critical Habitat Designations and PCE Descriptions

Summary of 14 Listed Species Identified as being on Agricultural Fields with and without Critical Habitat Designations for AL, GA, KY, MI, NC, SC and TX Assessed for dicamba DGA salt

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species with Critical Habitat Designations (5 Species)³</i>		
Houston toad (<i>Bufo houstonensis</i>)	Bastrop and Burleson Counties, Texas. Primary Constituent Elements not identified.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=D004#crithab http://ecos.fws.gov/docs/federal_register/fr179.pdf
Indiana bat (<i>Myotis sodalis</i>)	Critical habitat designations are either mines or caves.	http://ecos.fws.gov/docs/federal_register/fr161.pdf
Louisiana black bear (<i>Ursus americanus luteolus</i>)	PCE: Relatively inaccessible terrain, thick understory vegetation and abundant food sources in the form of shrubs or tree borne soft or hard mast. Currently found in bottomland hardwood forest communities. Home range very dependent on forest cover.	http://www.gpo.gov/fdsys/pkg/FR-2009-03-10/pdf/E9-4536.pdf#page=1
Virginia big-eared bat (<i>Corynorhinus</i> (= <i>Plecotus</i>) <i>townsendii virginianus</i>)	Critical habitat designations are caves.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A080#crithab http://ecos.fws.gov/docs/federal_register/fr366.pdf
Whooping crane (<i>Grus americana</i>)	PCE: All areas proposed in this rule would provide food, water, and other nutritional or physiological needs of the whooping crane during spring or fall migration. Consumption of some cereal crops in adjacent croplands during migration period. Direct relatable resources to agricultural field possibly treated with 2,4-D choline.	http://ecos.fws.gov/docs/federal_register/fr237.pdf
<i>Species without critical habitat designations (10 species)</i>		
American burying beetle (<i>Nicrophorus americanus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=I028#crithab
Attwater's greater prairie-chicken (<i>Tympanuchus cupido attwateri</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B000#crithab
Eastern indigo snake (<i>Drymarchon corais couperi</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C026#crithab
Eskimo curlew (<i>Numenius borealis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B01A#crithab

³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Gopher tortoise (<i>Gopherus polyphemus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C044#crithab
Gulf Coast jaguarundi (<i>Herpailurus (=Felis) yagouaroundi cacomitli</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A05H#crithab
Lesser prairie-chicken (<i>Tympanuchus pallidicinctus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0AZ#crithab
Ocelot (<i>Leopardus (Felis) pardalis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A084#crithab
Red wolf (<i>Canis rufus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00F#crithab

Summary of 292 Listed Species Identified as being off Agricultural Fields with and without Critical Habitat Designations for AL, GA, KY, MI, NC, SC and TX Assessed for dicamba DGA salt

Critical Habitat Designation	Species Name
<i>Species with Critical Habitat Designations (113 Species)⁴</i>	[Unnamed] ground beetle (<i>Rhadine exilis</i>)
	[Unnamed] ground beetle (<i>Rhadine infernalis</i>)
	Alabama beach mouse (<i>Peromyscus polionotus ammobates</i>)
	Alabama cavefish (<i>Speoplatyrhinus poulsoni</i>)
	Alabama moccasinshell (<i>Medionidus acutissimus</i>)
	Alabama pearlshell (<i>Margaritifera marrianae</i>)
	Alabama sturgeon (<i>Scaphirhynchus suttkusi</i>)
	Altamaha Spiny mussel (<i>Elliptio spinosa</i>)
	Amber darter (<i>Percina antesella</i>)
	Appalachian elktoe (<i>Alasmidonta raveneliana</i>)
	Arkansas River shiner (<i>Notropis girardi</i>)
	Austin blind salamander (<i>Eurycea waterlooensis</i>)
	Braken Bat Cave Meshweaver (<i>Cicurina venii</i>)
	Braun's rock-creep (<i>Arabis perstellata</i>)
	Cahaba shiner (<i>Notropis cahabae</i>)
	Canada lynx (<i>Lynx canadensis</i>)
	Cape Fear shiner (<i>Notropis mekistocholas</i>)
	Carolina heelsplitter (<i>Lasmigona decorata</i>)
	Chipola slabshell (<i>Elliptio chipolaensis</i>)

⁴ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

	Choctaw bean (<i>Villosa choctawensis</i>)
	Cokendolpher Cave Harvestman (<i>Texella cokendolpheri</i>)
	Comal Springs dryopid beetle (<i>Stygoparnus comalensis</i>)
	Comal Springs riffle beetle (<i>Heterelmis comalensis</i>)
	Conasauga logperch (<i>Percina jenkinsi</i>)
	Coosa moccasinshell (<i>Medionidus parvulus</i>)
	Cumberland darter (<i>Etheostoma susanae</i>)
	Cumberland elktoe (<i>Alasmidonta atropurpurea</i>)
	Cumberlandian combshell (<i>Epioblasma brevidens</i>)
	Dark pigtoe (<i>Pleurobema furvum</i>)
	Devils River minnow (<i>Dionda diaboli</i>)
	Diamond Y Spring snail (<i>Pseudotryonia adamantina</i>)
	Diminutive Amphipod (<i>Gammarus hyalleloides</i>)
	Fat three-ridge (mussel) (<i>Amblesma neislerii</i>)
	Finelined pocketbook (<i>Lampsilis altilis</i>)
	Fleshy-fruit gladecress (<i>Leavenworthia crassa</i>)
	Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)
	Fountain darter (<i>Etheostoma fonticola</i>)
	Frosted Flatwoods salamander (<i>Ambystoma cingulatum</i>)
	Fuzzy pigtoe (<i>Pleurobema strodeanum</i>)
	Georgetown salamander (<i>Eurycea naufragia</i>)
	Georgia pigtoe (<i>Pleurobema hanleyianum</i>)
	Golden sedge (<i>Carex lutea</i>)
	Goldline darter (<i>Percina aurolineata</i>)
	Gonzales springsnail (<i>Tryonia circumstriata</i>)
	Government Canyon Bat Cave Meshweaver (<i>Cicurina vespera</i>)
	Government Canyon Bat Cave Spider (<i>Neoleptoneta microps</i>)
	Green sea turtle (<i>Chelonia mydas</i>)
	Gulf moccasinshell (<i>Medionidus penicillatus</i>)
	Gulf sturgeon (<i>Acipenser oxyrinchus desotoi</i>)
	Hawksbill sea turtle (<i>Eretmochelys imbricata</i>)
	Helotes mold beetle (<i>Batrissodes ventyivi</i>)
	Hine's emerald dragonfly (<i>Somatochlora hineana</i>)
	Interrupted (=Georgia) Rocksnail (<i>Leptoxis foremani</i>)
	Jollyville Plateau salamander (<i>Eurycea tonkawae</i>)
	Karner blue butterfly (<i>Lycaeides melissa samuelis</i> Y)
	Kentucky cave shrimp (<i>Palaemonias ganteri</i>)
	Kentucky glade cress (<i>Leavenworthia exigua laciniata</i>)
	Leatherback sea turtle (<i>Dermochelys coriacea</i>)
	Leon Springs pupfish (<i>Cyprinodon bovinus</i>)
	Loggerhead sea turtle (<i>Caretta caretta</i>)
	Madla's Cave Meshweaver (<i>Cicurina madla</i>)
	Mexican spotted owl (<i>Strix occidentalis lucida</i>)
	Mountain golden heather (<i>Hudsonia montana</i>)
	Narrow pigtoe (<i>Fusconaia escambia</i>)
	Neches River rose-mallow (<i>Hibiscus dasycalyx</i>)

	North Atlantic Right Whale (<i>Eubalaena glacialis</i>)
	Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)
	Oval pigtoe (<i>Pleurobema pyriforme pyriforme</i>)
	Ovate clubshell (<i>Pleurobema perovatum</i>)
	Oyster mussel (<i>Epioblasma capsaeformis</i>)
	Peck's cave amphipod (<i>Stygobromus</i> (= <i>Stygonectes</i>) <i>pecki</i>)
	Pecos (=puzzle, =paradox) sunflower (<i>Helianthus paradoxus</i>)
	Pecos assiminea snail (<i>Assiminea pecos</i>)
	Perdido Key beach mouse (<i>Peromyscus polionotus trissyllepsis</i>)
	Phantom springsnail (<i>Pyrgulopsis texana</i>)
	Phantom tryonia (<i>Tryonia cheatumi</i>)
	Piping Plover (<i>Charadrius melodus</i>)
	Purple bankclimber (mussel) (<i>Elliptoideus sloatianus</i>)
	Pygmy Sculpin (<i>Cottus paulus</i> (= <i>pygmaeus</i>))
	Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)
	Reticulated flatwoods salamander (<i>Ambystoma bishopi</i>)
	Robber Baron Cave Meshweaver (<i>Cicurina baronia</i>)
	Rough hornsnail (<i>Pleurocera foremani</i>)
	Round Ebonyshell (<i>Fusconaia rotulata</i>)
	Rush Darter (<i>Etheostoma phytophilum</i>)
	Salado salamander (<i>Eurycea chisholmensis</i>)
	San Marcos gambusia (<i>Gambusia georgei</i>)
	San Marcos salamander (<i>Eurycea nana</i>)
	Sharpnose Shiner (<i>Notropis oxyrhynchus</i>)
	Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)
	Short's bladderpod (<i>Physaria globosa</i>)
	Slabside Pearlymussel (<i>Pleuonaia dolabelloides</i>)
	Slackwater darter (<i>Etheostoma boschungii</i>)
	Smalleye Shiner (<i>Notropis buccula</i>)
	Snail darter (<i>Percina tanasi</i>)
	Southern acornshell (<i>Epioblasma othcaloogensis</i>)
	Southern clubshell (<i>Pleurobema decisum</i>)
	Southern kidneyshell (<i>Ptychobranhus jonesi</i>)
	Southern pigtoe (<i>Pleurobema georgianum</i>)
	Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)
	Spotfin Chub (<i>Erimonax monachus</i>)
	Spruce-fir moss spider (<i>Microhexura montivaga</i>)
	Sunfish, spring pygmy (<i>Elassoma alabamae</i>)
	Tapered pigtoe (<i>Fusconaia burkei</i>)
	Texas Golden Gladecress (<i>Leavenworthia texana</i>)
	Texas wild-rice (<i>Zizania texana</i>)
	Triangular Kidneyshell (<i>Ptychobranhus greenii</i>)
	Upland combshell (<i>Epioblasma metastriata</i>)
	Vermilion darter (<i>Etheostoma chermocki</i>)
	Waccamaw silverside (<i>Menidia extensa</i>)
	West Indian Manatee (<i>Trichechus manatus</i>)

Species without Critical Habitat Designations (179 species)	Whorled Sunflower (<i>Helianthus verticillatus</i>)
	Zapata bladderpod (<i>Lesquerella thamnophila</i>)
	Alabama (=inflated) heelsplitter (<i>Potamilus inflatus</i>)
	Alabama canebrake pitcher-plant (<i>Sarracenia rubra alabamensis</i>)
	Alabama cave shrimp (<i>Palaemonias alabamae</i>)
	Alabama lampmussel (<i>Lampsilis virescens</i>)
	Alabama leather flower (<i>Clematis socialis</i>)
	Alabama red-belly turtle (<i>Pseudemys alabamensis</i>)
	Alabama streak-sorus fern (<i>Thelypteris pilosa</i> var. <i>alabamensis</i>)
	American chaffseed (<i>Schwalbea americana</i>)
	American hart's-tongue fern (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)
	Anthony's riversnail (<i>Athearnia anthonyi</i>)
	Armored snail (<i>Pyrgulopsis</i> (=Marstonia) <i>pachyta</i>)
	Ashy dogweed (<i>Thymophylla tephroleuca</i>)
	Bachman's warbler (=wood) (<i>Vermivora bachmanii</i>)
	Barton Springs salamander (<i>Eurycea sosorum</i>)
	Bee Creek Cave harvestman (<i>Texella reddelli</i>)
	Big Bend gambusia (<i>Gambusia gaigei</i>)
	Black lace cactus (<i>Echinocereus reichenbachii</i> var. <i>albertii</i>)
	Black spored quillwort (<i>Isoetes melanospora</i>)
	Black-capped Vireo (<i>Vireo atricapilla</i>)
	Blackside dace (<i>Phoxinus cumberlandensis</i>)
	Blue Ridge goldenrod (<i>Solidago spithamea</i>)
	Blue shiner (<i>Cyprinella caerulea</i>)
	Bone Cave harvestman (<i>Texella reyesi</i>)
	Boulder darter (<i>Etheostoma wapiti</i>)
	Bunched arrowhead (<i>Sagittaria fasciculata</i>)
	Bunched cory cactus (<i>Coryphantha ramillosa</i>)
	Canby's dropwort (<i>Oxypolis canbyi</i>)
	Carolina northern flying squirrel (<i>Glaucomys sabrinus coloratus</i>)
	Cherokee darter (<i>Etheostoma scotti</i>)
	Chisos Mountain hedgehog Cactus (<i>Echinocereus chisoensis</i> var. <i>chisoensis</i>)
	Clear Creek gambusia (<i>Gambusia heterochir</i>)
	Clubshell (<i>Pleurobema clava</i>)
	Coffin Cave mold beetle (<i>Batrissodes texanus</i>)
	Comanche Springs pupfish (<i>Cyprinodon elegans</i>)
	Cooley's meadowrue (<i>Thalictrum cooleyi</i>)
	Copperbelly water snake (<i>Nerodia erythrogaster neglecta</i>)
	Cracking pearlymussel (<i>Hemistena lata</i>)
	Cumberland bean (pearlymussel) (<i>Villosa trabalis</i>)

Cumberland monkeyface (pearlymussel) (<i>Quadrula intermedia</i>)
Cumberland rosemary (<i>Conradina verticillata</i>)
Cumberland sandwort (<i>Arenaria cumberlandensis</i>)
Cylindrical lioplax (snail) (<i>Lioplax cyclostomaformis</i>)
Davis' green pitaya (<i>Echinocereus viridiflorus</i> var. <i>davisii</i>)
Dromedary pearlymussel (<i>Dromus dromas</i>)
Duskytail darter (<i>Etheostoma percnurum</i>)
Dwarf lake iris (<i>Iris lacustris</i>)
Dwarf wedgemussel (<i>Alasmidonta heterodon</i>)
Dwarf-flowered heartleaf (<i>Hexastylis naniflora</i>)
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)
Etowah darter (<i>Etheostoma etowahae</i>)
False killer whale (<i>Pseudorca crassidens</i>)
Fanshell (<i>Cyprogenia stegaria</i>)
Fat pocketbook (<i>Potamilus capax</i>)
Finback whale (<i>Balaenoptera physalus</i>)
Finerayed pigtoe (<i>Fusconaia cuneolus</i>)
Flat pebblesnail (<i>Lepyrium showalteri</i>)
Flat pigtoe (<i>Pleurobema marshalli</i>)
Flattened musk turtle (<i>Sternotherus depressus</i>)
Florida torreyia (<i>Torreya taxifolia</i>)
Fringed campion (<i>Silene polypetala</i>)
Gentian pinkroot (<i>Spigelia gentianoides</i>)
Golden-cheeked warbler (=wood) (<i>Dendroica chrysoparia</i>)
Gray bat (<i>Myotis grisescens</i>)
Green pitcher-plant (<i>Sarracenia oreophila</i>)
Hairy rattleweed (<i>Baptisia arachnifera</i>)
Harperella (<i>Ptilimnium nodosum</i>)
Heavy pigtoe (<i>Pleurobema taitianum</i>)
Heller's blazingstar (<i>Liatris helleri</i>)
Hinckley oak (<i>Quercus hinckleyi</i>)
Houghton's goldenrod (<i>Solidago houghtonii</i>)
Humpback whale (<i>Megaptera novaeangliae</i>)
Hungerford's crawling water Beetle (<i>Brychius hungerfordi</i>)
James spinymussel (<i>Pleurobema collina</i>)
Johnston's frankeni (<i>Frankenia johnstonii</i>)
Kemp's ridley sea turtle (<i>Lepidochelys kempii</i>)
Kirtland's Warbler (<i>Setophaga kirtlandii</i>)
Kral's water-plantain (<i>Sagittaria secundifolia</i>)
Kretschmarr Cave mold beetle (<i>Texamaurops reddelli</i>)
Lacy elimia (snail) (<i>Elimia crenatella</i>)
Lakeside daisy (<i>Hymenoxys herbacea</i>)
Large-flowered skullcap (<i>Scutellaria montana</i>)
Large-fruited sand-verbena (<i>Abronia macrocarpa</i>)
Leafy prairie-clover (<i>Dalea foliosa</i>)

	Least tern (<i>Sterna antillarum</i>)
	Little Aguja (=Creek) Pondweed (<i>Potamogeton clystocarpus</i>)
	Little amphianthus (<i>Amphianthus pusillus</i>)
	Littlewing pearlymussel (<i>Pegias fabula</i>)
	Lloyd's Mariposa cactus (<i>Echinomastus mariposensis</i>)
	Louisiana quillwort (<i>Isoetes louisianensis</i>)
	Lyrate bladderpod (<i>Lesquerella lyrata</i>)
	Mat-forming quillwort (<i>Isoetes tegetiformans</i>)
	Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)
	Miccosukee gooseberry (<i>Ribes echinellum</i>)
	Michaux's sumac (<i>Rhus michauxii</i>)
	Michigan monkey-flower (<i>Mimulus michiganensis</i>)
	Mitchell's satyr Butterfly (<i>Neonympha mitchellii mitchellii</i>)
	Mohr's Barbara button (<i>Marshallia mohrii</i>)
	Morefield's leather flower (<i>Clematis morefieldii</i>)
	Mountain sweet pitcher-plant (<i>Sarracenia rubra</i> ssp. <i>Jonesii</i>)
	Navasota ladies'-tresses (<i>Spiranthes parksii</i>)
	Nellie cory cactus (<i>Coryphantha minima</i>)
	No common name (<i>Geocarpon minimum</i>)
	Noonday globe (<i>Patera clarki nantahala</i>)
	Northern aplomado falcon (<i>Falco femoralis septentrionalis</i>)
	Northern riffleshell (<i>Epioblasma torulosa rangiana</i>)
	Orangefoot pimpleback (pearlymussel) (<i>Plethobasus cooperianus</i>)
	Orangenacre mucket (<i>Lampsilis perovalis</i>)
	Painted rocksnail (<i>Leptoxis taeniata</i>)
	Pale lilliput (pearlymussel) (<i>Toxolasma cylindrellus</i>)
	Palezone shiner (<i>Notropis albizonatus</i>)
	Pallid sturgeon (<i>Scaphirhynchus albus</i>)
	Pecos gambusia (<i>Gambusia nobilis</i>)
	Persistent trillium (<i>Trillium persistens</i>)
	Pink mucket (pearlymussel) (<i>Lampsilis abrupta</i>)
	Pitcher's thistle (<i>Cirsium pitcheri</i>)
	Plicate rocksnail (<i>Leptoxis plicata</i>)
	Pondberry (<i>Lindera melissifolia</i>)
	Price's potato-bean (<i>Apios priceana</i>)
	purple cat's paw (=purple cat's paw pearlymussel) (<i>Epioblasma obliquata obliquata</i>)
	Rayed Bean (<i>Villosa fabalis</i>)
	Red Hills salamander (<i>Phaeognathus hubrichti</i>)
	Red-cockaded woodpecker (<i>Picoides borealis</i>)
	Relict darter (<i>Etheostoma chienense</i>)
	Relict trillium (<i>Trillium reliquum</i>)
	Ring pink (mussel) (<i>Obovaria retusa</i>)
	Roan Mountain bluet (<i>Hedyotis purpurea</i> var. <i>montana</i>)
	Rock gnome lichen (<i>Gymnoderma lineare</i>)

Roseate tern (<i>Sterna dougallii dougallii</i>)
Rough pigtoe (<i>Pleurobema plenum</i>)
Rough-leaved loosestrife (<i>Lysimachia asperulaefolia</i>)
Round rocksnail (<i>Leptoxis ampla</i>)
Running buffalo clover (<i>Trifolium stoloniferum</i>)
Saint Francis' satyr butterfly (<i>Neonympha mitchellii francisci</i>)
Schweinitz's sunflower (<i>Helianthus schweinitzii</i>)
Seabeach amaranth (<i>Amaranthus pumilus</i>)
Sensitive joint-vetch (<i>Aeschynomene virginica</i>)
Sheepnose Mussel (<i>Plethobasus cyphus</i>)
Shiny pigtoe (<i>Fusconaia cor</i>)
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)
Short's goldenrod (<i>Solidago shortii</i>)
Slender campeloma (<i>Campeloma decampi</i>)
Slender rush-pea (<i>Hoffmannseggia tenella</i>)
Small whorled pogonia (<i>Isotria medeoloides</i>)
Small-anthered bittercress (<i>Cardamine micranthera</i>)
Smalltooth sawfish (<i>Pristis pectinata</i>)
Smooth coneflower (<i>Echinacea laevigata</i>)
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)
Snuffbox mussel (<i>Epioblasma triquetra</i>)
South Texas ambrosia (<i>Ambrosia cheiranthifolia</i>)
Southern combshell (<i>Epioblasma penita</i>)
Southern sandshell (<i>Hamiota</i> (= <i>Lampsilis</i>) <i>australis</i>)
Spectaclecase (mussel) (<i>Cumberlandia monodonta</i>)
Sperm whale (<i>Physeter catodon</i> (= <i>macrocephalus</i>))
Spreading avens (<i>Geum radiatum</i>)
Star cactus (<i>Astrophytum asterias</i>)
Stirrupshell (<i>Quadrula stapes</i>)
Swamp pink (<i>Helonias bullata</i>)
Tar River spinymussel (<i>Elliptio steinstansana</i>)
Tennessee yellow-eyed grass (<i>Xyris tennesseensis</i>)
Terlingua Creek cat's-eye (<i>Cryptantha crassipes</i>)
Texas ayenia (<i>Ayenia limitaris</i>)
Texas blind salamander (<i>Typhlomolge rathbuni</i>)
Texas poppy-mallow (<i>Callirhoe scabriuscula</i>)
Texas prairie dawn-flower (<i>Hymenoxys texana</i>)
Texas snowbells (<i>Styrax texanus</i>)
Texas trailing phlox (<i>Phlox nivalis</i> ssp. <i>texensis</i>)
Tobusch fishhook cactus (<i>Sclerocactus brevihamatus</i> ssp. <i>tobuschii</i>)
Tooth Cave ground beetle (<i>Rhadine persephone</i>)
Tooth Cave pseudoscorpion (<i>Tartarocreagris texana</i>)
Tooth Cave Spider (<i>Leptoneta myopica</i>)
Tulotoma snail (<i>Tulotoma magnifica</i>)
Virginia spiraea (<i>Spiraea virginiana</i>)

	Walker's manioc (<i>Manihot walkerae</i>)
	Watercress darter (<i>Etheostoma nuchale</i>)
	White bladderpod (<i>Lesquerella pallida</i>)
	White irisette (<i>Sisyrinchium dichotomum</i>)
	White wartyback (pearlymussel) (<i>Plethobasus cicatricosus</i>)
	White-haired goldenrod (<i>Solidago albopilosa</i>)
	Wood stork (<i>Mycteria americana</i>)
	Yellow blossom (pearlymussel) (<i>Epioblasma florentina florentina</i>)

Appendix 6

U.S. Fish and Wildlife Service Concurrence Memo for Eskimo Curlew Effects Determination

From: Swem, Ted [mailto:ted_swem@fws.gov]
Sent: Monday, May 11, 2015 5:40 PM
To: Wagman, Michael
Subject: Re: Eskimo Curlew (Dicamba ESA assessment)

Dear Mr. Wagman

Regrettably, we do concur with your determination. Although we prefer to hold out hope and have not removed the Eskimo Curlew from the list of Threatened and Endangered Species, we consider it to be "presumed extinct." We believe therefore that there are none left to encounter pesticides applied anywhere, and thus agree that the effects of the proposed action are discountable.

Thank you for checking in, though.

Ted Swem

On Mon, May 11, 2015 at 1:33 PM, Wagman, Michael <Wagman.Michael@epa.gov> wrote:

Ted Swem, Chief,

Endangered Species Branch,

Fairbanks Fish and Wildlife Field Office,

US Fish and Wildlife Service (907) 456-0441

Dear Mr. Swem

The USEPA Office of Pesticide Programs is in the process of making an effects determination for the registration of the herbicide dicamba diglycolamine (DGA) salt on cotton and soybean fields in Texas, Nebraska and Oklahoma. Use of the pesticide will be limited to ground spray application using a formulation and specific spray equipment in combination to spray drift setbacks that result in pesticide application areas of concern limited to only the actual on-field treatment site (the targeted cotton or soybean field itself).

Our review of available species location information suggests a potential for a migrant Eskimo curlew (*Numenius borealis*) passing through Texas, Nebraska and Oklahoma to encounter a treated field with dicamba DGA residues. Our analysis indicates that if such an encounter occurred, the residue levels that would trigger a concern for adverse effects to the bird. However, in reviewing the available information on the status of the Eskimo curlew¹, we have determined that individuals of the species are extremely rare. This rarity of individuals

indicates to us that the chance of an individual curlew to encounter a dicamba DGA treated cotton or soybean field would be extremely unlikely to occur. Therefore any effects of dicamba DGA salt to an Eskimo curlew would be extremely unlikely to occur.

An effect that is extremely unlikely to occur would be considered discountable in regards to an effects determination and would be consistent with a determination of Not Likely to Adversely Affect. We therefore have determined that the proposed use of dicamba DGA salt on cotton and soybeans in Texas, Nebraska and Oklahoma will Not Likely to Adversely Affect individual Eskimo curlews.

Does the United States Fish and Wildlife Service concur with our effects determination?

Sincerely,

Michael Wagman
Biologist, Environmental Risk Branch VI
Environmental Fate and Effects Division
Office of Pesticide Programs
United States Environmental protection Agency
703-347-0198

¹ Eskimo Curlew (*Numenius borealis*) 5-Year Review: Summary and Evaluation, August 31, 2011, U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks Alaska



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode : 425049

Date: March 24, 2016

MEMORANDUM

Subject: Addendum to Dicamba Diglycolamine Salt (DGA) and its Degradate, 3,6-dichlorosalicylic acid (DCSA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 11 U.S. States: (Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia).

To: Grant Rowland, Risk Manager Reviewer
Kathryn Montague, Product Manager Team 23
Dan Kenny, Branch Chief
Herbicide Branch
Pesticide Registration Division (7505P)
Office of Pesticide Programs

From: Elizabeth Donovan, Biologist
Michael Wagman, Biologist
Monica Wait, Risk Assessment Process Leader
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Elizabeth Donovan 3/24/16
Michael Wagman 3/24/16
Monica Wait 3/24/16

Through: Mark Corbin, Branch Chief
Environmental Risk Branch 6
Environmental Fate and Effects Division (7507P)
Office of Pesticide Programs

Mark Corbin 3-24-16

Prior to conducting this refined Endangered Species Assessment, the Environmental Fate and Effects Division (EFED) performed a screening level ecological risk assessment for a Federal action involving proposed new uses of the diglycolamine salt of dicamba (dicamba DGA) on dicamba herbicide-tolerant soybean on March 8, 2011 (DP 378444); an amendment to the assessment was issued on May 20, 2014 (DP 404138, 404806, 405887, 410802, and 411382). Concurrent with this refined Endangered Species Assessment, a Section 3 New Use dicamba DGA salt on dicamba-tolerant cotton screening-level assessment (DP 404823) and a subsequent addendum (DP 426789) that addresses multiple issues (spray drift buffers, runoff, risk to terrestrial invertebrates and updated mammalian toxicological endpoints for parent dicamba and its degradate, DCSA) have been finalized. In the screening level risk assessment, potential direct risk concerns could not be excluded for:

- mammals (chronic, from the soybean use only, due to residues from dicamba's metabolite, DCSA, rather than from parent dicamba);
- birds (acute from parent dicamba for both soybean and cotton uses; chronic from DCSA residues only in soybean but not in cotton), considered surrogates for reptiles, and terrestrial-phase amphibians; and
- terrestrial plants (soybean and cotton uses)

In the screening level risk assessments, indirect effect risk concerns for all taxa were possible for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants. Additionally, the screening level assessment showed that direct risk concerns were unlikely (*i.e.* levels of concern were not exceeded) for:

- mammals (acute) and (chronic—for the cotton use only);
- birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton);
- terrestrial insects (acute and chronic);
- freshwater fish (acute and chronic);
- aquatic-phase amphibians (acute and chronic);
- estuarine/marine fish (acute and chronic);
- freshwater invertebrates (acute and chronic); estuarine/marine invertebrates (acute and chronic); and
- aquatic plants¹

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that

¹ The listed species LOC was exceeded for non-vascular aquatic plants, however there are no listed species of this taxa.

includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations. At each screening step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still exceeds the Agency’s levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. When a given taxonomic RQ exceeds either the acute or chronic LOC a concern for direct toxic effects is identified for that particular taxon. If RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

The purpose of this document is to explain the refined risk assessment conducted for Federally-listed threatened or endangered (listed) species that could potentially be impacted by this pesticide registration. The refined assessment was conducted based on the 2004 Overview document, as discussed above. The assessment of risks to listed species posed by the use of Dicamba DGA has been conducted in phases covering a specific set of states, assessing risk to all the listed species covered in those states. This assessment covers the endangered species analysis for 11 states: Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia (AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV). Based on EFED’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), 322 species in the 11 states proposed for registration were identified as within the action area (at a preliminary county-wide level of resolution) associated with the new herbicide-tolerant soybean and cotton uses. **Table 1** below presents a

summary of this assessment. Separate concurrent assessment phases cover the endangered species analysis for 16 states (Arkansas, Kansas, Louisiana, Illinois, Indiana, Iowa, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin (DP 416416, 420160, 420159, 420352, 421434, 421723)) and 7 states (Alabama, Georgia, Kentucky, Michigan, North Carolina, South Carolina, and Texas (DP 422305)).

EPA consulted U.S. Fish and Wildlife Service Recovery Plans to determine whether listed species in these states would be expected to occur in an action area encompassing the treated soybean and corn fields. The refined assessment was then conducted on those species that could not be excluded from the action area. EPA also consulted the recovery plans in the refined assessment for additional habitat information and incorporated species biological information regarding dietary items (used to model dicamba DGA residues in prey tissue) and body weight (used to determine food consumption rates and scale ecotoxicity data from the tested surrogate species, the bobwhite quail and rat, to the body weight of the listed species).

The Environmental Fate and Effects Division (EFED) has completed an endangered species risk assessment for Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia in support of registering dicamba diglycolamine (DGA) salt on herbicide-tolerant cotton and soybean in these states. **Table 1** presents a summary of the assessment.

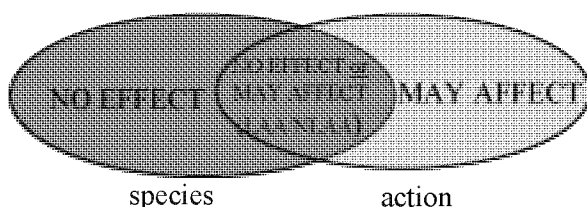
Table 1. Summary of species effects determinations and critical habitat modification determinations for Federally listed threatened or endangered species in Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia and West Virginia for dicamba DGA use on genetically modified cotton and soybeans.

Species	Effects Determination	Comments
Audubon Crested Caracara	May Affect, Not Likely to Adversely Affect for Palm Beach County (Cotton only; concurrence by USFWS pending) No effect (soybean; and for cotton in all other counties except Palm Beach)	The species is found in 22 counties in Florida. However, no county has soybean production and only one county has any cotton: Palm Beach County
All other species (terrestrial and aquatic)	No effect	
Critical Habitat	Modification Determination	Comments
All Critical Habitats (322 species)	No Modification	None

Making an Effects Determination

The bullets below outline EFED's process for making an effects determination for the Federal action:

- For listed individuals inside the action area but **NOT** part of an affected taxa **NOR** relying on the affected taxa for services (involving food, shelter, biological mediated resources necessary for survival/reproduction), use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY AFFECT (LIKELY or NOT LIKELY TO ADVERSELY AFFECT) categories depending upon their specific biological needs, circumstances of exposure, etc.



- **LIKELY or NOT LIKELY TO ADVERSELY AFFECT** determinations are made using the following criteria:
 - Insignificant - The level of the effect cannot be meaningfully related to a “take.”
 - Highly Uncertain - The effect is highly unlikely to occur.
 - Wholly beneficial - The effects are only good things.

Spray Drift Mitigation

EFED's refined endangered species risk assessment took into account the spray drift mitigation language that was added to the most recent proposed label submitted by the registrant. An accounting of federally-listed threatened or endangered species within the 11 states (covered in this assessment) proposed for dicamba DGA use on genetically modified cotton and soybeans is included in **Appendix 1** (322 species). Specifically, the spray drift mitigation language on the M1691 Herbicide Supplemental labels for the use dicamba DGA salt on ROUNDUP READY 2 XTEND™ soybean and BOLLGARD II® XTENDFLEX cotton includes the following limitations:

Specifically, the spray drift mitigation language includes the following limitations:

- Specifying the use of a nozzle (Tee Jet® TTI11004) with ASABE S-572 ultra-coarse and extremely coarse droplet spectra and a maximum operating pressure of 63 psi.

- A maximum equipment ground speed of 15 miles per hour and ground boom height of 24 inches above the target pest or crop canopy.
- Restricting all applications when wind speeds are < 3 mph or > 15 mph and restricting applications when wind is blowing towards sensitive areas at > 10 mph. Maintaining use of a 110 foot in-field buffer for a 0.5 lb a.i./A application (220 foot in-field buffer for a 1 lb a.i./A application) when the wind is blowing towards any areas that are not fields in crop cultivation, paved areas, or areas covered by buildings and other structures.
- Applications done in low relative humidity conditions are to use equipment set to produce larger droplet spectra to compensate for evaporation.
- Applications are not be conducted during temperature inversions.
- In order to prevent effects to non-target susceptible plants, the label also includes the following language: “do not apply under circumstances where spray drift may occur to food, forage or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants because severe injury or destruction may result, including plants in a greenhouse. Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from the off-target movement of M1691 Herbicide. The Applicator must survey the application site for neighboring sensitive areas prior to application. The applicator also should consult sensitive crop registries for locating sensitive areas where available.”
- Finally, in order to prevent unintended damage from the drift of M1691 Herbicide, the label says not to apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

The incorporation of the spray drift mitigation measures into the product labeling as outlined above would result in exposure to dicamba DGA from spray drift at a level where effects are expected only within the confines of the treated field and so the action area is limited to the dicamba DGA treated field. Further, the incorporation of the “susceptible plants” spray drift mitigation language on the label is to avoid damage to these plants (including adjacent crops). Because the risk assessment interprets the threshold for plant damage concern to be based on the most sensitive plant species tested and the screening level ecological risk assessment has demonstrated that these plant effects endpoints constitute the most conservative terrestrial organism levels of effect, it is concluded that the “susceptible plants” requirement requires a level of drift mitigation that would also prevent less sensitive organisms from being exposed at levels of concern. Terrestrial species that are not expected to occur on treated fields under the provisions of the proposed label are not expected to be directly exposed to dicamba DGA, nor are their critical biologically mediated resources expected to be exposed to levels of the herbicide above any effects thresholds of concern. Additionally, as indicated in the screening level ecological risk assessments for cotton and soybean, no aquatic receptor taxa are of concern for drift or runoff exposure (LOCs were not exceeded for aquatic taxa). **Consequently, all but 14 of the 322 listed species originally identified as potentially at-risk are determined to be**

given a “no effect” (NE) without further refinement because they are not expected to occur in an action area encompassing the treated soybean and cotton fields (Appendix 2). The remaining 14 species are assessed using the refinements set forth in the 2004 Overview document referred to earlier in this assessment and considering the restrictions contained in the proposed labeling, species specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment.

Exposure through Runoff

The cotton screening-level risk assessment and the concurrently issued soybean addendum characterized risk following exposure to dicamba residues in runoff and found that the predicted concentrations from modeling were lower than the most sensitive taxa’s endpoint (soybean plant height). Combining the predictions of this modeling, the toxicological endpoints and that most of the off-site plant community would not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concluded that all available lines of evidence supported a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, rainfast mitigation on the label would also protect against the risk of exposure to listed species off the treated field.

In addition to the spray drift and runoff mitigation measures contained in the proposed labeling, EFED analyzed species-specific biology, dicamba-specific foliar residue data and dicamba application timing information in this refined endangered species assessment. An accounting of the federally-listed threatened or endangered species within the 11 states proposed for this registration showed 322 listed species as potentially at risk (direct or indirect effects) as a result of the screening-level assessment (**Appendix 1**). The spray drift mitigation label language cannot preclude listed species being exposed to dicamba DGA salt or DCSA residues on treated fields, should a listed species utilize such areas as part of its range and corresponding habitat. Of the 322 listed species within the 11 states (AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV) considered part of the proposed Federal decision, the following 14 species were reasonably expected to occur on soybean and cotton fields, which could potentially be treated with dicamba and therefore could not be assumed to be “no effect” solely on the basis of occurrence outside the action area:

Of these 14 species, a “no effect” determination was reached in the concurrent assessment actions for 16 states (DP 416416, 420160, 420159, 420352, 421434, 421723 covering AR, IL, IA, IN, KS, LA, MN, MS, MO, NE, ND, OH, OK, SD, TN, and WI) and 7 states (DP 422305 covering AL, GA, KY, MI, NC, SC, and TX) for the following species and is applicable to these 11 states as well:

- Eastern indigo snake (*Drymarchon corais couperi*)
- Indiana bat (*Myotis sodalis*)
- Lesser prairie-chicken (*Tympanuchus pallidicinctus*)
- Virginia big-eared bat (*Corynorhinus (=Plecotus) townsendii virginianus*)

- Ocelot (*Leopardus (Felis) pardalis*)
- Whooping crane (*Grus americana*)
- Red wolf (*Canis rufus*)
- Gray wolf (*Canis lupus*)

This leaves the following species for which the remainder of this document uses species specific biological information and dicamba DGA use patterns in more depth to further refine the assessment and effects determinations:

- California condor (*Gymnogyps californianus*)
- Audubon's crested caracara (*Polyborus plancus audubonii*)
- Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*)
- Jaguar (*Panthera onca*)
- Florida panther (*Puma (=felis) concolor coryi*)
- Sonoran pronghorn (*Antilocapra americana sonoriensis*)

Therefore, species specific biological information (e.g., body size, dietary requirements, and seasonality) and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations.

This assessment also uses the refined exposure values determined in the cotton screening level assessment and the concurrently issued addendum to the soybean screening level risk assessment documents compared to the initial exposure estimates from the soybean screening level assessment. This ESA assessment also evaluates chronic exposures from DCSA separately from the chronic exposure to parent dicamba. Dicamba exposure values were determined from the upper bound of the modeled T-REX run for exposures following spray applications based on the Kenaga nomogram modified by Fletcher *et al* (1984), which is based on a large set of actual field residue data. Modeled dicamba exposure values were identical between the soybean addendum and the cotton screening level risk assessment (since the maximum application rates and minimum application intervals are the same).

Similar modeling of DCSA residues, which are formed inside the tolerant-soybean and tolerant-cotton plants through plant metabolism, is not feasible at this time due to a lack of sufficient data tracking DCSA residues in plant tissues over time to ascertain degradation rates. Therefore, in the soybean addendum and the cotton screening-level risk assessment, EFED used the maximum empirical measured DCSA residue concentrations in dicamba-tolerant soybean (61.1 mg/kg (ppm) DCSA in broadleaf plants and 0.440 ppm in soybean seeds) and cotton plant tissues (6.29 ppm DCSA in cotton gin byproducts and 0.27 ppm in undelinted cotton seed) to evaluate chronic exposures to DCSA for animals foraging on soybean and cotton plants. Residues in arthropods (as a dietary item for birds and mammals consuming insects that have consumed soybean/cotton tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications (*i.e.* arthropod concentrations estimated to be approximately 70% of the concentrations in broadleaf plant tissues or 42.5 ppm

DCSA in arthropods feeding on soybean plants and 4.4 ppm in arthropods feeding on cotton plants). The empirical residue data for cotton indicated that chronic exposures of birds and mammals to dicamba or DCSA in cotton tissues *would not* be above any levels of concern. Although the concurrently issued soybean addendum indicates that chronic risk to mammals and birds was only a concern from DCSA residues in plant/prey tissues and not from residues of parent dicamba, since the original soybean screening-level assessment (USEPA, 2011) indicated chronic risk to mammals, this assessment presents the estimated exposures and comparisons to threshold toxicity values for both dicamba and DCSA for mammals, but evaluates them separately since their chronic toxicity and exposure profiles differ greatly. For birds, following the conclusions of the screening level assessments and the soybean addendum, only acute risk from dicamba exposures and chronic risk from DCSA exposures is evaluated.

The following text discusses the lines of evidence and processes that were used to make effects determinations for listed species identified as potentially at-risk in the screening level assessment.

Refined ecological risk assessment for the remaining species potentially exposed to dicamba residues

For the effects determinations for California condor, Audobon's crested caracara, Delmarva Peninsula fox squirrel, jaguar, Florida panther and Sonoran pronghorn, a refined risk assessment approach was used to evaluate additional lines of evidence to determine whether the conservative generic assumptions in the screening risk assessment apply to a particular species of interest (e.g. the California condor). In the case of the California condor, the refined risk assessment investigated the impacts of more condor-specific data related to:

1. Bird size (as the condor is larger than the 1000g large bird category used in the initial screen)
- 2.. Bird food consumption tailored to:
 - a. The true weight of the bird
 - b. Energy requirements of the condor
 - c. Improvement on the generic food intake model of the screen to assess energy content of the diet and the actual free living energy requirements of a bird the size of a California condor
3. Toxicity endpoints scaled from the weight of the tested surrogate species (bobwhite quail) to reflect the comparatively larger actual size of the condor.

Using the California condor as the example to show how EPA made its effects determinations, EPA determined that the California condor could be primarily feeding on carcasses of large mammals that may have been present in treated cotton and soybean fields. EPA therefore assumed that the predicted concentrations of dicamba DGA salt found in large (1000g) mammals that were exclusively feeding on short grass exposed to dicamba residues from the spray application would be a conservative prey analysis for the condor consistent with the preliminary risk concerns identified in the screening assessments. For chronic exposures to DCSA residues, EPA assumed the prey mammal was feeding exclusively on soybean forage containing the

maximum measured DCSA concentrations. This analysis is conservative as it assumes 1) that 100% of the condor's food consumption comes from 1kg mammals that have fed exclusively on dicamba exposed short grass (the dietary item with the highest modeled residue levels) or DCSA residues in exposed dicamba-tolerant soybean plants (the only plants that would have significant DCSA residues) and 2) the level of dicamba DGA residues assumed to be on the consumed short grass is based on the upper bound Kenaga residues expected for short grass directly exposed to spray applications of dicamba DGA while the level of DCSA residues is assumed to be the maximum measured concentration (61.1 ppm). Additionally, using the residues in a 1 kg mammal carcass is also likely conservative, given that condor primarily feeds on larger prey species such as deer, elk, feral pigs, livestock, horses, and pinnipeds. EPA determined the field metabolic rate of the California condor through the use of a published peer reviewed allometric equation that relates bodyweight to energy requirements. Values were obtained from a published peer reviewed EPA document produced by the Office of Research and Development for Agency-wide use in conducting ecological risk assessment (USEPA, 1993) and the work of Dunning, 1984. The mass of dicamba DGA in the mammalian prey diet is determined from the T-REX run found in the addendum to the screening-level risk assessment (USEPA, 2016a), issued concurrently with this refined risk assessment. The mass of prey consumed per day is then multiplied by mass of dicamba in the mammal's diet to determine the mass of dicamba or DCSA in the condor's daily diet in mg/day. Then the daily dose that the condor (considering its bodyweight) receives is determined by multiplying the mass of dicamba or DCSA in the exposed mammalian prey (which had consumed exclusively exposed plants) divided by the bodyweight of the condor. Then EPA scaled the acute toxicity endpoint (based on the tested surrogate bird species, bobwhite quail's default weight of 178 grams) to the bodyweight of the California condor to determine the acute oral toxicity for the condor. For exposures to DCSA residues, the chronic toxicity endpoint for the mallard (the most sensitive tested species) was modified by the relationship between the chronic dicamba and DCSA endpoints for rats (a 17x difference). The acute RQ for dicamba exposures is then calculated by dividing the daily dose of dicamba from consuming the exposed mammal carcasses by the acute oral toxicity endpoint while the chronic RQ is calculated by dividing the daily dose of DCSA by the chronic toxicity endpoint. In this case, the acute RQ was 0.01, which is below the endangered species level of concern of 0.1 while the chronic RQ was 0.02 which is below the listed and non-listed species chronic LO of 1.0. At this point, EPA was able to conclude that dicamba DGA would not have an effect on the California condor.

Birds

The screening-level assessments showed that birds could be at risk of mortality from acute exposures to dicamba DGA on treated fields, but chronic risk was not expected as no chronic RQs exceeded the Agency's LOC (1.0) for chronic risk (USEPA 2011. D378444, p. 15). The concurrently issued soybean addendum did indicate that chronic exposures to DCSA residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, for listed species that could reasonably be expected to occur on treated soybean and cotton fields, EPA conducted a refined assessment for acute (dicamba only) and chronic (DCSA only, and only for soybean) exposures. Of the remaining bird species identified as potentially at acute risk in the seven states, two are reasonably expected to occur on treated soybean and cotton

fields. Therefore, species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for those species.

California condor

Dicamba Acute Effects Assessment

Initial screening level risk assessment results for birds showed concerns for acute effects. The species' 5-Year review (USFWS, 2013) describes the condor as an obligate scavenger feeding primarily on large mammalian carcasses including deer, elk, feral pigs, livestock, horses, and pinnipeds, though smaller carrion may also be consumed. The assumptions in the initial screen were adjusted to account for the condor's biology:

The first step in the refinement process is to calculate dicamba DGA residues in the prey species. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, EFED calculated the residues in this prey as 40.17 mg dicamba DGA salt/kg-bw (T-REX modeling from concurrently issued dicamba soybean addendum).

The next step is to calculate the expected daily dose for a typical 10 kg (10000 g, Dunning 1984) condor, the adjusted LD₅₀ value, and the acute dose-based RQ for the condor based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.301(10000)^{0.75})/(1-0.69)/1000 = 0.97 \text{ kg wet/day}$$

$$\begin{aligned} \text{Dose-based EEC in condor eating large mammal} &= 40.17 \text{ mg/kg wet} \times 0.97/(10000/1000) \\ &= \mathbf{3.90 \text{ mg/kg-bw/day}} \end{aligned}$$

$$\text{Adjusted LD}_{50} = 188 \text{ mg/kg-bw} (10000/178)^{(1.15-1)} = \mathbf{344 \text{ mg/kw-bw}}$$

$$\text{Acute Dose-Based RQ} = 3.90/344 = \mathbf{0.01}$$

An RQ of 0.01 does not exceed the LOC of 0.1; **consequently a “no effect” determination is concluded for the California condor.**

DCSA Assessment for California condor consuming prey that had previously consumed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

$$1000 \text{ g mammal prey ingestion rate (dry)} = 0.621(1000)^{0.564} = 30.56 \text{ g/day}$$

$$1000 \text{ g mammal prey ingestion rate (wet)} = 30.56/0.2 = 152.8 \text{ g/day}$$

$$\text{DCSA residue in prey eating soybean forage/hay } 61.1 \text{ mg DCSA/kg-food (ww)} \times 0.1528 \text{ kg food/kg-bw} = \mathbf{9.34 \text{ mg/kg-bw/day}}$$

The next step is to calculate the expected daily dose for a typical 10 kg (10000 g, Dunning 1984) condor, the adjusted LD₅₀ value, and the acute dose-based RQ for the condor based on the following allometric equations:

$$\text{Food Intake (wet)} = (0.301(10000)^{0.75})/(1-0.69)/1000 = 0.97 \text{ kg wet/day}$$

$$\text{Dose-based EEC in condor eating large mammal} = 9.34 \text{ mg/kg wet} \times 0.97/(10000/1000) = \mathbf{0.91 \text{ mg/kg-bw/day}}$$

Avian Chronic Endpoint of 695 mg/kg-diet (from mallard duck study for parent dicamba) modified by ratio of parent dicamba to metabolite DCSA from chronic rat studies (17x) results in Avian chronic NOAEC of **40.88 mg/kg-diet**.

$$\text{Chronic Dose-Based RQ} = 0.91/40.88 = \mathbf{0.02}$$

Audubon's Crested Caracara

Dicamba Acute Effects Assessment

The five year review (USFWS 2009) of the caracara indicated that current habitat use includes (ranked highest to lowest proportion): improved pasture, dry prairie, freshwater marsh, mixed upland hardwoods, shrub swamp, shrub and brushland, grassland, pinelands, bare soil, urban, other agriculture, citrus, and scrub. It is therefore considered likely that individual birds may make use of cultivated soybean and cotton fields as potential foraging habitat.

Initial screening level risk assessment results for birds indicated concerns for acute effects. The assumptions in the initial screen were adjusted to account for the caracara's biology:

The first step in the refinement process is to calculate dicamba DGA residues in the prey species. The caracara is an opportunistic predator of a variety of terrestrial vertebrates and invertebrates (USFWS 1999). In evaluating dicamba residues from the screening risk assessment, the residues for a small bird consuming short grass exceed those of other dietary items (such as arthropods) and so conservatively serve as a dietary exposure pathway for this species-specific risk assessment, and EFED calculates the residues as 299.47 mg DGA/kg-bw (T-REX modeling from concurrently issued dicamba soybean addendum). This is a conservative approach as it assumes that the caracara is feeding exclusively on a prey species represented by a small (20g) bird feeding exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba.

The next step is to calculate the expected daily dose for a typical 900g (Dunning 1984) bird, the adjusted LD₅₀ value, and the acute dose-based RQ for the caracara based on the following allometric equations:

Field metabolic rate kcal/day = $1.146(900)^{0.749} = 187$ kcal/day (USEPA 1993, body weight Dunning 1984).

Mass of prey consumed per day = $187 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.78 \text{ AE}) = 141 \text{ g/day}$ (1.7 is energy content of prey item from USEPA (1993); 0.78 is assimilation efficiency from USEPA 1993, assumption of small mammal prey from Biological Information on Listed Species of Amphibians and Model Parameterization for Pesticide Effects Determinations, United States Environmental Protection Agency, Office of Pesticide Programs July 15, 2013)

Mass of dicamba DGA in 20 g small bird diet item = 299.47 mg/kg-ww from T-REX run

Mass of dicamba in daily diet = $141 \text{ g/day} \times 299.47 \text{ mg dicamba/kg-ww small bird prey} \times 0.001 = 42.23 \text{ mg/day}$

Daily dose in caracara = $42.23 \text{ dicamba/day} / 0.9 = \mathbf{46.92 \text{ mg/kg-bw/day}}$

Adjusted LD₅₀ = $188 \text{ mg/kg-bw} (900/178)^{(1.15-1)} = \mathbf{239.74 \text{ mg/kg-bw}}$

Acute Dose-Based RQ = $46.92/239.74 = \mathbf{0.20}$

An RQ of 0.20 exceeds the LOC of 0.1, suggesting that even at a more refined level of assessment for this species an effect is possible should the species be found in treated fields. Similar though lower RQs would follow for consumption of small mammals (screening assessment dicamba residue 250.70 mg/kg, but not for the more likely insect diet during preplant with screening assessment residues of 102.99 mg/kg).

The analysis suggests that if a caracara is feeding in a cotton or soybean field, then there is a potential for a lethal event. Establishing a potential for overlap between species range and the cropped areas proposed for treatment is an important consideration in how likely an exposure event might be for individual caracara. To evaluate overlap between cotton or soybean and a specific species range, a GIS co-occurrence analysis was conducted. The caracara's range was compared to the aggregated National Agricultural Statistics Service (NASS) reported acres from the 2012 Census of Agriculture Full Report, and the 5 year aggregated USDA Cropland Data Layer (CDL) crop group layers. The most recent species range file provided by U.S Fish and Wildlife Service headquarters office, as of May 26, 2015, was used for these analyses.

To calculate the NASS overlap, first all the reported crops from the 2012 Census of Agriculture Full Report were cross walked into the 11 EFED crop groups for each county. All counties within the species range were selected from the aggregated crop group table, each crop was summed to generate the total NASS acres, and then percent overlap was calculated.

The CDL is the best available land cover data to spatially characterize agricultural crops nationally. As with any land cover data, there will be errors present. The accuracy of the CDL is well documented on a state by state basis. Essentially, major commodity crops have a more robust training and validation dataset than minor crops, and their accuracy values correspond accordingly. Several methods have been employed to minimize data errors within the CDL.

The CDL has over 100 cultivated classes hierarchically grouped into 11 general classes. Combining classes reduces errors of omission and commission between similar crop categories. The CDL is also annually produced. Five years of CDL from 2010-2014 were temporally aggregated. The concept is that anywhere a class occurs within those 5 years is represented as a temporally aggregated individual class. Temporal aggregation also accounts for crop rotations.

The CDL's agricultural classes were further refined by comparing county level NASS 2012 Census of Agriculture (CoA) acreage reports to county level CDL acreages. If a county's CDL acreage for a given class was lower than the CoA, EPA expanded the CDL class's extent within cultivated areas until the CDL acreage matched the CoA acreage. Using the temporally and thematically aggregated CDL as an input, EPA developed a script that compares each CDL crop group in each county to the corresponding CoA acreage report. If the CDL acreage was less than NASS, EPA expanded the raster in 1 pixel iterations until the CoA value was reached, or the area within the county's cultivated mask was built out. Region growing was restricted using the most recent CDL Cultivated Layer as a mask, so as to avoid buffering into any non-agricultural land cover types. This method reduces land cover mapping errors by adjusting the extent of each category to the best available census values.

To calculate the overlap of the 5-year CDL-aggregated layers, the zonal statistics tool in ArcGIS was used to count the pixels for each layer within the species range. These counts were converted to an area measurement, and the percent overlap calculated. The intersection of the maps represents the geographical extent of overlap of caracara habitat with cotton and soybeans. None of the Audubon's crested caracara's range overlaps with soybean using either the NASS or CDL datasets. Using the NASS dataset, none of the caracara's range overlaps with cotton production while using the CDL dataset <0.00001% of the established range overlaps with cotton (1 acre cotton coverage overlap within the caracara's habitat in Palm Beach County). As the crop overlap analysis suggests no soybean cropland co-occurrence with caracara range, EPA **concludes a No Effect (NE) determination for the soybean use.**

On the basis of the extremely low identified proportion of the distribution of the species, the co-occurrence of the species with treated cotton is determined to not occur in the majority of the caracara range (<0.00001%), and to be highly unlikely to occur in the one county with any cotton acreage (Palm Beach County with 1 acre of cotton according to the CDL dataset).

Consequently, if the dicamba cotton label does not restrict Palm Beach County, EPA would conclude a May Affect/Not Likely to Adversely Affect (NLAA) determination for the Audubon's Crested Caracara with Palm Beach County (concurrence pending) while a No Effect (NE) determination would be concluded for the other counties in the caracara's

range. If use in Palm Beach County was excluded on the cotton label, than EPA would also conclude a No Effect determination for the cotton use.

DCSA Assessment for Audubon caracara

Given the acute analysis for parent dicamba DGA and the conclusion of a No effect or May Affect/Not Likely to Adversely Affect determination based on a lack of co-occurrence of the caracara with soybean and cotton production outside of Palm Beach County and extremely low co-occurrence in Palm Beach County, further analysis was deemed unnecessary for the DCSA degrade effects to the caracara.

Mammals

The screening-level assessments indicated that acute risk to mammals was not expected as no acute RQs exceeded the Agency's LOC (0.1) for acute risk (USEPA 2011. D378444, p. 15). However, the soybean screening-level assessment (USEPA, 2011) indicated that mammals could be at reproductive risk from chronic exposures to dicamba DGA on treated fields, though the cotton screening level and concurrently issued soybean addendum (USEPA, 2016a and USEPA, 2016b) indicated that chronic exposures to dicamba DGA would be below the chronic LOC (1.0). This difference is due to soybean screening level risk assessment's use of a chronic endpoint from the rat 2-generation study (MRID 43137101), of 45 mg/kg-bw for the NOAEL, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016c; D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, as pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. Therefore, the cotton screening level risk assessment, the concurrently issued soybean addendum and this refined endangered species risk assessment use this revised NOAEL for dicamba DGA salt.

The concurrently issued soybean addendum did indicate that chronic exposures to dicamba's metabolite, DCSA, residues in soybean could be a concern, while the screening level cotton assessment indicated that chronic exposures to DCSA residues in cotton would not exceed the Agency's LOC for chronic risk. Therefore, EPA only conducted a refined assessment for chronic exposures to DCSA in soybeans for listed species that could reasonably be expected to occur on treated soybean fields.

Of the mammalian species identified as potentially at risk in the eleven states, four are reasonably expected to occur on treated soybean fields. Species specific biological information and dicamba DGA use patterns were considered in more depth to further refine the assessment and effects determinations for the four species potentially expected to occur on treated soybean fields.

Delmarva Peninsula fox squirrel

Dicamba Chronic Effects Assessment

The recovery plan for the squirrel (USFWS 1993; http://ecos.fws.gov/docs/recovery_plan/930608.pdf) discusses a number of food items for the organism, however much of the discussion centers on forest habitat and its resources. The document does mention the squirrel's association with woodlands proximal to corn and soybean fields. Corn, soybean, and other grains provide reliable supplemental food according to Sheperd and Swihart (1995). However, it is unlikely, given the toxic gossypol content of cotton seed, that the plant provides similar resources as soybean for the squirrel. The following represents a refined risk assessment considering the body mass associated energy requirements of the squirrel and the use of soybeans as a food source.

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Using the conservative assumption that 100% of the fox squirrel's diet is made up of exposed soybean seed/grain having received the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for fox squirrel's biology:

Field metabolic rate kcal/day = $2.514(800)^{0.507} = 74.51$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the fox squirrel from Recovery Plan (USFWS 1993; http://ecos.fws.gov/docs/recovery_plan/930608.pdf))

Mass of soybean seed consumed per day = $74.51 \text{ kcal/day} / (5 \text{ kcal/g ww} \times 0.85 \text{ AE}) = 17.5$ g/day
(5 is energy content of seed item from USEPA (1993); 0.85 is assimilation efficiency for seeds consumed by rodents from USEPA 1993)

Mass of dicamba DGA in seed/grain diet 17.74 mg/kg-ww from T-REX run
(conservative estimate of exposure for the fox squirrel's diet of tree mast, buds, flowers, insects, fruit, seeds etc. and available dietary items in agricultural fields).

Mass of dicamba DGA in daily diet = $17.5 \text{ g/day} \times 16.43 \text{ mg dicamba DGA/kg-ww seed} \times 0.001 = 0.29$ mg/day

Daily dose in fox squirrel = $0.29 \text{ mg dicamba DGA/day} / 0.8 \text{ kg} = 0.36 \text{ mg/kg-bw/day}$

Fox squirrel NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} (350/800)^{(0.25)} = 110.61 \text{ mg/kg-bw}$

The RQ for chronic effects = $0.36/110.61 = 0.003$

A chronic RQ of 0.003 does not exceed the chronic LOC of 1.0. **Consequently, it is reasonable to make a "no effect" determination for the Delmarva Peninsula fox squirrel.**

DCSA Analysis for Delmarva Fox Squirrel consuming DCSA residues present in soybean grain

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Using the conservative assumption that 100% of the fox squirrel's diet is made up of exposed soybean seed/grain having containing the maximum measured DCSA residues, exposure assumptions from the screening assessment were adjusted to account for fox squirrel's biology:

Field metabolic rate kcal/day = $2.514(800)^{0.507} = 74.51$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the fox squirrel from Recovery Plan (USFWS 1993; http://ecos.fws.gov/docs/recovery_plan/930608.pdf))

Mass of soybean seed/grain consumed per day = $74.51 \text{ kcal/day} / (5 \text{ kcal/g ww} \times 0.85 \text{ AE}) = 17.5$ g/day
(5 is energy content of seed item from USEPA (1993); 0.85 is assimilation efficiency for seeds consumed by rodents from USEPA 1993)

Mass of DCSA in seed/grain diet 0.44 mg/kg-ww (maximum empirical residues for the most likely available dietary items (soybean grain) in agricultural fields).

Mass of DCSA in daily diet = $17.5 \text{ g/day} \times 0.44 \text{ mg DCSA/kg-ww seed} \times 0.001 = 0.008$ mg/day

Daily dose in fox squirrel = $0.008 \text{ mg DCSA /day} / 0.8 \text{ kg} = \mathbf{0.01 \text{ mg/kg-bw/day}}$

Fox squirrel NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} (350/800)^{(0.25)} = \mathbf{6.51 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.01/6.51 = \mathbf{0.001}$

An chronic RQ of 0.001 does not exceed the chronic LOC of 1.0. **Consequently, it is reasonable to make a “no effect” determination for the Delmarva Peninsula fox squirrel.**

Jaguar

Dicamba Chronic Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Jaguars are ambush hunters with large home ranges, capable of feeding on a wide variety of prey, though medium-sized (1-10 kg) and larger prey appear to be much more commonly used than smaller prey species (USFWS, 2012, Rosas-Rosas, 2006 and López-González and Miller, 2002). Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the

upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the jaguar's biology:

Field metabolic rate kcal/day = $0.6167(45000)^{0.862} = 6326$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the jaguar from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of prey consumed per day = $6326 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 4430$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of dicamba DGA in 1 kg mammal diet 40.17 mg/kg-ww (conservative estimate for a 1 kg mammal feeding on short grass) from T-REX run

Mass of dicamba DGA in daily diet = $4430 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 178$ mg/day

Daily dose in jaguar = $178 \text{ mg dicamba DGA/day} / 45 \text{ kg} = \mathbf{3.95 \text{ mg/kg-bw/day}}$

Jaguar NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/45000)^{(0.25)} = \mathbf{40.39 \text{ mg/kg-bw}}$

The RQ for chronic effects = $3.95/40.39 = 0.10$.

A chronic RQ of 0.10 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the jaguar.**

DCSA Assessment for Jaguar consuming prey that had previously consumed exposed soybean forage

Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed soybean forage containing the maximum measured DCSA residues (61.1 mg/kg), exposure assumptions from the screening assessment were adjusted to account for the jaguar's biology:

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56 \text{ g/day}$

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8 \text{ g/day}$

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 45 kg jaguar, the adjusted NOAEL value and the chronic dose-based RQ for the jaguar based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(45000)^{0.862} = 6326 \text{ kcal/day}$
(USEPA 1993, body weight reflects screening assumption for the jaguar from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of prey consumed per day = $6326 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 4430 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2012; http://ecos.fws.gov/docs/recovery_plan/049777%20-%20Jaguar%20Recovery%20Outline%20-%20April%202012_2.pdf)

Mass of DCSA in 1 kg mammal diet = 9.34 mg/kg-ww (conservative estimate for a 1 kg mammal feeding on soybean forage containing the maximum measured empirical residues of 61.1 mg/kg)

Mass of DCSA in daily diet = $4430 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 41.38 \text{ mg/day}$

Daily dose in jaguar = $41.38 \text{ mg DCSA/day} / 45 \text{ kg} = \mathbf{0.92 \text{ mg/kg-bw/day}}$

Jaguar NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} \times (350/45000)^{(0.25)} = \mathbf{2.38 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.92/2.38 = 0.39$

A chronic RQ of 0.39 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the jaguar.**

Florida Panther

Dicamba Chronic Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects. The recovery plan (USFWS, 2008) describes the panther as a wide ranging animal primarily feeding on white-tailed deer and feral hogs with secondary prey including raccoon, armadillos, rabbits and alligators. Using the conservative assumptions that the prey species is represented by a 1000 g mammal that feeds exclusively on exposed short grass receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the panther's biology:

Field metabolic rate kcal/day = $0.6167(34000)^{0.862} = 4968$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the typical panther female from Recovery Plan, USFWS 2008)

Mass of prey consumed per day = $4968 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 3479 \text{ g/day}$
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2008)

Mass of dicamba DGA in 1 kg mammal diet 40.17 (conservative estimate for a 1kg mammal feeding on short grass) mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $3479 \text{ g/day} \times 40.17 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 139.75 \text{ mg/day}$

Daily dose in panther = $139.75 \text{ mg dicamba DGA /day} / 34 \text{ kg} = 4.11 \text{ mg/kg-bw/day}$

Panther NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/34000)^{(0.25)} = 43.32 \text{ mg/kg-bw}$

The RQ for chronic effects = $4.11/43.32 = 0.09$

A chronic RQ of 0.09 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the panther.**

DCSA Assessment for Florida panther consuming prey that had consumed exposed soybean forage

The first step in the refinement process is to calculate DCSA residues in the prey species. Using the assumption that the prey species is represented by a 1000 g mammal and the conservative assumptions that the prey animal feeds exclusively on exposed soybean forage containing the maximum measured residues of 61.1 ppm, EFED calculated the residues based on the following allometric equations (USEPA, 1993):

1000 g mammal prey ingestion rate (dry) = $0.621(1000)^{0.564} = 30.56 \text{ g /day}$

1000 g mammal prey ingestion rate (wet) = $30.56/0.2 = 152.8$ g/day

DCSA residue in prey eating soybean forage/hay 61.1 mg DCSA/kg-food (ww) x 0.1528 kg food/kg-bw = **9.34 mg/kg-bw/day**

The next step is to determine the expected daily dose for a typical 34 kg panther, the adjusted NOAEL value and the chronic dose-based RQ for the panther based on the following allometric equations:

Field metabolic rate kcal/day = $0.6167(34000)^{0.862} = 4968$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the typical panther female from Recovery Plan, USFWS 2008)

Mass of prey consumed per day = $4968 \text{ kcal/day} / (1.7 \text{ kcal/g ww} \times 0.84 \text{ AE}) = 3479$ g/day
(1.7 is energy content of prey item from USEPA (1993); 0.84 is assimilation efficiency from USEPA 1993, 1 kg mammal diet from Recovery Plan, USFWS 2008)

Mass of DCSA in 1 kg mammal diet 9.34 (conservative estimate for a 1kg mammal feeding on soybean forage containing the maximum measured empirical residues of 61.1 mg/kg-ww)

Mass of DCSA in daily diet = $3479 \text{ g/day} \times 9.34 \text{ mg DCSA/kg-ww mammal prey} \times 0.001 = 32.49$ mg/day

Daily dose in panther = $32.49 \text{ mg DCSA /day} / 34 \text{ kg} = \mathbf{0.96 \text{ mg/kg-bw/day}}$

Panther NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} \times (350/34000)^{(0.25)} = \mathbf{2.55 \text{ mg/kg-bw}}$

The RQ for chronic effects = $0.96/2.55 = 0.38$

A chronic RQ of 0.38 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the panther.**

Sonoran pronghorn

Dicamba Chronic Effects Assessment

Initial screening level risk assessment results for mammals identified concerns for chronic effects. Pronghorn consume forbs such as buckwheat, ragweed, milkvetch and borage species as well as some woody species including ironwood and mesquite and succulent fruit such as chain-fruit cholla (USFWS, 2015). Though many agricultural crops do not provide adequate forage for the pronghorn, some, such as alfalfa do (USFWS, 2015). Therefore, it is possible that pronghorn

may forage on agricultural crops such as soybean. Given the toxic gossypol content of cotton plant parts, it is unlikely that this plant provides similar resources as soybean for the pronghorn. Using the conservative assumptions that the pronghorn is exclusively consuming exposed broadleaf plants (the most likely dietary item with the highest modeled dicamba residues) receiving the upper bound Kenaga residues from the spray application of dicamba, exposure assumptions from the screening assessment were adjusted to account for the pronghorn's biology:

Field metabolic rate kcal/day = $1.419(47630)^{0.727} = 3571$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the pronghorn from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of broadleaf plants consumed per day = $3571 \text{ kcal/day} / (0.63 \text{ kcal/g ww} \times 0.76 \text{ AE}) = 7458 \text{ g/day}$ (0.63 is energy content of broadleaf dietary item from USEPA (1993); 0.76 is assimilation efficiency from USEPA 1993, broadleaf plant diet from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of dicamba DGA in broadleaf plant diet 147.91 mg/kg-ww from T-REX run

Mass of dicamba DGA in daily diet = $7458 \text{ g/day} \times 147.91 \text{ mg dicamba DGA/kg-ww mammal prey} \times 0.001 = 1103 \text{ mg/day}$

Daily dose in pronghorn = $1103 \text{ mg dicamba DGA/day} / 47.63 = \mathbf{23.16 \text{ mg/kg-bw/day}}$

Pronghorn NOAEL mg/kg-bw/day = $136 \text{ mg/kg-bw} \times (350/47630)^{(0.25)} = \mathbf{39.82 \text{ mg/kg-bw}}$

The RQ for chronic effects = $23.16/39.82 = 0.58$.

A chronic RQ of 0.58 does not exceed the chronic LOC of 1.0. **Consequently, a “no effect” determination is made for the pronghorn.**

DCSA Analysis for Pronghorn

Using the conservative assumptions that the pronghorn is exclusively consuming exposed soybean plants containing the maximum measured DCSA residues (61.1 mg/kg), exposure assumptions from the screening assessment were adjusted to account for the pronghorn's biology:

Field metabolic rate kcal/day = $1.419(47630)^{0.727} = 3571$ kcal/day
(USEPA 1993, body weight reflects screening assumption for the pronghorn from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of soybean forage consumed per day = $3571 \text{ kcal/day} / (0.63 \text{ kcal/g ww} \times 0.76 \text{ AE}) = 7458 \text{ g/day}$ (0.63 is energy content of broadleaf dietary item from USEPA (1993); 0.76 is assimilation efficiency from USEPA 1993, broadleaf plant diet from Recovery Plan, USFWS 2003; http://ecos.fws.gov/docs/recovery_plan/031126.pdf)

Mass of DCSA in broadleaf plant diet 61.1 mg/kg-ww (maximum measured concentrations in soybean forage)

Mass of DCSA in daily diet = $7458 \text{ g/day} \times 61.1 \text{ mg DCSA/kg-ww soybean forage} \times 0.001 = 455.68 \text{ mg/day}$

Daily dose in pronghorn = $455.68 \text{ mg dicamba DGA/day} / 47.63 = \mathbf{9.57 \text{ mg/kg-bw/day}}$

Pronghorn NOAEL mg/kg-bw/day = $8 \text{ mg/kg-bw} \times (350/47630)^{(0.25)} = \mathbf{2.34 \text{ mg/kg-bw}}$

The RQ for chronic effects = $9.57/2.34 = \mathbf{4.09}$

A chronic RQ of 4.09 exceeds the chronic LOC of 1.0, suggesting that an effect is possible should the species be found in treated soybean fields (There were no exceedances for mammals feeding on DCSA contaminated cotton tissues based on the Section 3 screening level risk assessment. However, similar calculations conducted for pronghorn feeding in cotton fields would result in an RQ of 0.42, based on the maximum measured DCSA residues in cotton. As this would be below the LOC, a “**no effect**” (NE) determination could be made for pronghorn feeding on cotton fields)

This analysis suggests that if a pronghorn is feeding in a soybean field there is a potential for a lethal event. Establishing a potential for overlap between species range and the cropped areas proposed for treatment is an important consideration in how likely an exposure event might be for individual pronghorn.

To evaluate overlap between cotton and soybean and a specific species range a GIS co-occurrence analysis was conducted. Specific species range maps for the pronghorn are not currently available. However, the U.S. Fish and Wildlife Species Profile Page² identifies the pronghorn to be known or believed to occur in Yuma, Pinal, Maricopa, Pima, La Paz and Santa Cruz counties. The pronghorn recovery plan (USFWS, 1998) describes pronghorn habitat as broad alluvial valleys ranging in elevation from 122 meters in the west to 488 meters in the east. Using the county and elevation information, the species' range was compared to the aggregated NASS reported acres from the 2012 Census of Agriculture Full Report, and the 5 year aggregated CDL crop group layers.

https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A009. Accessed 6/16/2015.³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

To calculate the NASS overlap, first all the reported crops from the 2012 Census of Agriculture Full Report were cross walked into the 11 EFED crop groups for each county. All counties within the species range were selected from the aggregated crop group table, each crop was summed to generate the total NASS acres, and then percent overlap was calculated.

The CDL is the best available land cover data to spatially characterize agricultural crops nationally. As with any land cover data, there will be errors present. The accuracy of the CDL is well documented on a state by state basis. Essentially, major commodity crops have a more robust training and validation dataset than minor crops, and their accuracy values correspond accordingly. Several methods have been employed to minimize data errors within the CDL.

The CDL has over 100 cultivated classes hierarchically grouped into 11 general classes. Combining classes reduces errors of omission and commission between similar crop categories. The CDL is also annually produced. Five years of CDL from 2010-2014 were temporally aggregated. The concept is that anywhere a class occurs within those 5 years is represented as a temporally aggregated individual class. Temporal aggregation also accounts for crop rotations.

The CDL's agricultural classes were further refined by comparing county level NASS 2012 Census of Agriculture (CoA) acreage reports to county level CDL acreages. If a county's CDL acreage for a given class was lower than the CoA, EPA expanded the CDL class's extent within cultivated areas until the CDL acreage matched the CoA acreage. Using the temporally and thematically aggregated CDL as an input, EPA developed a script that compares each CDL crop group in each county to the corresponding CoA acreage report. If the CDL acreage was less than NASS, EPA expanded the raster in 1 pixel iterations until the CoA value was reached, or the area within the county's cultivated mask was built out. Region growing was restricted using the most recent CDL Cultivated Layer as a mask, so as to avoid buffering into any non-agricultural land cover types. This method reduces land cover mapping errors by adjusting the extent of each category to the best available census values.

To calculate the overlap of the 5 year CDL-aggregated layers, the zonal statistics tool in ArcGIS was used to count the pixels for each layer within the species range. These counts were converted to an area measurement, and the percent overlap calculated. This process was repeated to calculate the overlap of each crop group layer with the species range between 122 and 488 m using the National Elevation Dataset. The National Elevation Dataset was downloaded on May 26, 2015 from: <http://ned.usgs.gov/>.

In Yuma, Pinal, Maricopa, Pima, La Paz and Santa Cruz counties between 122 and 488 meters, there was no identified soybean production according to either the NASS or CDL datasets. Cotton production was limited to 0.24% (CDL) to 0.74% (NASS) of the area in those counties at this elevation. Since the screening level assessment identified that risks to mammals are not anticipated for dicamba use on dicamba-tolerant cotton (levels of concern were not exceeded for exposure to either dicamba or its degradate DCSA), **a No Effect (NE) determination is concluded for pronghorn feeding on cotton fields.** Since the crop overlap analysis suggests

that there is no soybean cropland co-occurrence with pronghorn range, EPA also **concludes a No Effect (NE) determination for pronghorn from soybean uses**

Critical Habitat Determinations

In addition to the species-specific effects determinations, EFED also conducted a critical habitat modification analysis consistent with the Overview Document as discussed earlier in this refined assessment. The critical habitat modification analysis is based on an assessment of how dicamba DGA salt would affect the U.S. Fish and Wildlife Service or National Marine Fisheries Service (the Services) established principle constituent elements (PCE's) of the designated habitat as well as how direct species effects outcomes would impact critical habitat's present and future utility for promoting the conservation of a particular listed species. The Agency will conclude "modification" of designated critical habitat if the range of designated critical habitat co-occurs with the states subject to the Federal action and one or more of the following conditions exist:

1. The available Services' information indicates that cotton or soybean fields are habitat for the species and there is a "may affect" determination for the species associated with exposure to dicamba DGA salt or its degradate, DCSA, as labeled.
2. The available Services' information indicates that the species uses cotton or soybean fields and one or more effects on taxonomic groups predicted for dicamba DGA salt or its degradate DCSA, on cotton and soybean fields would modify one or more of the designated PCEs.

If neither of the above conditions are met, EPA concludes "no modification."

Results of Analysis

Of the 322 listed species within the states, there are 308 species identified in the effects determinations as not using cotton or soybean fields and 14 species using these fields (**Appendix 3**). Critical habitats have been designated for 122 of the 322 species. One-hundred sixteen (116) species with critical habitat were judged to not use cotton or soybean fields and so the critical habitat determination for these species was "no modification."

The remaining 6 species with critical habitat designations were assumed to use cotton or soybean fields and so the previous listed species effects determinations were consulted to ascertain if any were determined to be at risk for direct adverse effects. None of the species were determined to be at risk for direct adverse effects, so the PCE's listed in the Services' critical habitat designations were consulted to determine if, in light of the screening assessment risk findings, they would be impacted by on-field exposure to dicamba DGA salt. For all but one of these species, the PCE's are not relatable to agricultural fields and so a determination of no modification has been made for these 5 species.

The only remaining species using cotton or soybean fields and with critical habitat PCE's relatable to agricultural fields was the whooping crane, for which agricultural fields were discussed as providing waste grain as a potential food source for migratory cranes. The only way the proposed dicamba DGA salt could affect this PCE is by making grain potentially toxic to the birds. As there is unlikely to be any edible waste grain remaining following cotton harvesting, it is unlikely that the proposed dicamba DGA salt use on cotton could affect this PCE, however the proposed use on soybean could affect this PCE by making waste soybean grain potentially toxic.

The Health Effects Division summarized available soybean grain residues of dicamba in the Human Health Risk Assessment for the Registration Eligibility Decision for Dicamba and Associated Salts (DP317703). Based on the soybean trials results, maximum residues of dicamba were 0.04 ppm in hay, 0.097 ppm in forage, and 8.13 ppm in seed 6-8 days post treatment (MRIDs 43814101 and 44089307). These measured values were used to set the tolerance value of 10 ppm for soybean seeds. The measured residues are not reasonably expected to be at a level raising a concern for direct effects to the whooping crane because the direct effects assessment for this species (presented in the Section 3 Risk Assessment Refined Endangered Species Assessment that assessed risks to endangered species in 16 states (Arkansas, Kansas, Louisiana, Illinois, Indiana, Iowa, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin {DP 416416, 420160, 420159, 420352, 421434, 421723})) did not establish a concern for residues in other dietary items at much **higher** (~ 1 order of magnitude) concentrations than would occur at the maximum measured residues in seed or if residues were present even at the tolerance level of 10.0 ppm. Because this analysis shows no direct effects of dicamba at levels that would be expected in the fields as waste grain, an indirect effect, there is no modification of critical habitat. Similarly, measured DCSA residues in waste soybean grain (0.44 ppm) would be well below the estimated DCSA concentrations in arthropods (42.5 ppm) used in the direct effects assessment for this species (D416516+, pp. 9-10). Therefore, whooping crane critical habitat within the 11 states in this refined assessment would not be modified.

Summary of Determinations for Critical Habitat

The Agency has determined that the proposed labeled use of dicamba DGA salt on cotton and soybeans will not modify designated critical habitat for all 122 species for which such habitats have been designated in AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV.

A summary of listed species identified as not being on agricultural fields with and without critical habitat designations for the seven states assessed for dicamba DGA salt is provided in **Appendix 3**.

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Appendix 1

Threatened and Endangered Species in Arizona, Colorado, Delaware, Florida, Maryland, New Mexico, New Jersey, New York, Pennsylvania, Virginia, and West Virginia

Common Name	Scientific Name	Taxon
Indiana bat	<i>Myotis sodalis</i>	Mammal
Black-footed ferret	<i>Mustela nigripes</i>	Mammal
Gray wolf	<i>Canis lupus</i>	Mammal
Finback whale	<i>Balaenoptera physalus</i>	Mammal
Humpback whale	<i>Megaptera novaeangliae</i>	Mammal
North Atlantic Right Whale	<i>Eubalaena glacialis</i>	Mammal
Gray bat	<i>Myotis grisescens</i>	Mammal
Canada Lynx	<i>Lynx canadensis</i>	Mammal
Virginia big-eared bat	<i>Corynorhinus (=Plecotus) townsendii virginianus</i>	Mammal
Ocelot	<i>Leopardus (=Felis) pardalis</i>	Mammal
Carolina northern flying squirrel	<i>Glaucomys sabrinus coloratus</i>	Mammal
Mexican long-nosed bat	<i>Leptonycteris nivalis</i>	Mammal
Red-cockaded woodpecker	<i>Picoides borealis</i>	Bird
Mexican spotted owl	<i>Strix occidentalis lucida</i>	Bird
Piping Plover	<i>Charadrius melodus</i> except Great Lakes watershed	Bird
Piping Plover	<i>Charadrius melodus</i> Great Lakes watershed	Bird
Least tern	<i>Sterna antillarum</i>	Bird
Roseate tern	<i>Sterna dougallii dougallii</i>	Bird
Southwestern willow flycatcher	<i>Empidonax traillii eximius</i>	Bird
Lesser Prairie-Chicken	<i>Tympanuchus pallidicinctus</i>	Bird
Whooping crane	<i>Grus americana</i>	Bird
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Reptile
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Reptile
Loggerhead sea turtle	<i>Caretta caretta</i>	Reptile
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Reptile
Green sea turtle	<i>Chelonia mydas</i>	Reptile
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Fish
Pecos gambusia	<i>Gambusia nobilis</i>	Fish
Spotfin Chub	<i>Erimonax monachus</i>	Fish
Slender chub	<i>Erimystax cahni</i>	Fish
Yellowfin madtom	<i>Noturus flavipinnis</i>	Fish
Blackside dace	<i>Phoxinus cumberlandensis</i>	Fish
Arkansas River shiner	<i>Notropis girardi</i>	Fish
Smalleye Shiner	<i>Notropis buccula</i>	Fish
Duskytail darter	<i>Etheostoma percnurum</i>	Fish
Cumberland bean (pearlymussel)	<i>Villosa trabalis</i>	Bivalve
Choctaw bean	<i>Villosa choctawensis</i>	Bivalve

Purple bean	<i>Villosa perpurpurea</i>	Bivalve
Appalachian monkeyface (pearlymussel)	<i>Quadrula sparsa</i>	Bivalve
Chipola slabshell	<i>Elliptio chipolaensis</i>	Bivalve
Cumberland monkeyface (pearlymussel)	<i>Quadrula intermedia</i>	Bivalve
Fat three-ridge (mussel)	<i>Amblema neislerii</i>	Bivalve
Fuzzy pigtoe	<i>Pleurobema strodeanum</i>	Bivalve
Pink mucket (pearlymussel)	<i>Lampsilis abrupta</i>	Bivalve
Dromedary pearlymussel	<i>Dromus dromas</i>	Bivalve
Round Ebonyshell	<i>Fusconaia rotulata</i>	Bivalve
Littlewing pearlymussel	<i>Pegias fabula</i>	Bivalve
Finerayed pigtoe	<i>Fusconaia cuneolus</i>	Bivalve
Gulf moccasinshell	<i>Medionidus penicillatus</i>	Bivalve
Narrow pigtoe	<i>Fusconaia escambia</i>	Bivalve
Ochlockonee moccasinshell	<i>Medionidus simpsonianus</i>	Bivalve
Oval pigtoe	<i>Pleurobema pyriforme</i>	Bivalve
Rough pigtoe	<i>Pleurobema plenum</i>	Bivalve
Shinyrayed pocketbook	<i>Lampsilis subangulata</i>	Bivalve
Shiny pigtoe	<i>Fusconaia cor</i>	Bivalve
Southern kidneyshell	<i>Ptychobranhus jonesi</i>	Bivalve
Southern sandshell	<i>Hamiota (=Lampsilis) australis</i>	Bivalve
Spectaclecase (mussel)	<i>Cumberlandia monodonta</i>	Bivalve
Tan ruffleshell	<i>Epioblasma florentina walkeri (=E. walkeri)</i>	Bivalve
Tapered pigtoe	<i>Fusconaia burkei</i>	Bivalve
Rayed Bean	<i>Villosa fabalis</i>	Bivalve
Clubshell	<i>Pleurobema clava</i>	Bivalve
Cumberlandian combshell	<i>Epioblasma brevidens</i>	Bivalve
Oyster mussel	<i>Epioblasma capsaeformis</i>	Bivalve
Cracking pearlymussel	<i>Hemistena lata</i>	Bivalve
Slabside Pearlymussel	<i>Pleuonaia dolabelloides</i>	Bivalve
James spinymussel	<i>Pleurobema collina</i>	Bivalve
Dwarf wedgemussel	<i>Alasmidonta heterodon</i>	Bivalve
Fanshell	<i>Cyprogenia stegaria</i>	Bivalve
Northern ruffleshell	<i>Epioblasma torulosa rangiana</i>	Bivalve
Purple bankclimber (mussel)	<i>Elliptoideus sloatianus</i>	Bivalve
Snuffbox mussel	<i>Epioblasma triquetra</i>	Bivalve
Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	Bivalve
Fluted kidneyshell	<i>Ptychobranhus subtentum</i>	Bivalve
Sheepnose Mussel	<i>Plethobasus cyphus</i>	Bivalve
Pecos assiminea snail	<i>Assiminea pecos</i>	Gastropod
Karner blue butterfly	<i>Lycaeides melissa samuelis</i>	Insect
Mitchell's satyr Butterfly	<i>Neonympha mitchellii mitchellii</i>	Insect

Spruce-fir moss spider	<i>Microhexura montivaga</i>	Arachnid
Colorado Butterfly plant	<i>Gaura neomexicana</i> var. <i>coloradensis</i>	Dicot
Pecos (=puzzle, =paradox) sunflower	<i>Helianthus paradoxus</i>	Dicot
Northern wild monkshood	<i>Aconitum noveboracense</i>	Dicot
Small-anthered bittercress	<i>Cardamine micranthera</i>	Dicot
Sneed pincushion cactus	<i>Coryphantha sneedii</i> var. <i>sneedii</i>	Dicot
Small whorled pogonia	<i>Isotria medeoloides</i>	Monocot
Sensitive joint-vetch	<i>Aeschynomene virginica</i>	Dicot
Smooth coneflower	<i>Echinacea laevigata</i>	Dicot
Swamp pink	<i>Helonias bullata</i>	Monocot
Canby's dropwort	<i>Oxypolis canbyi</i>	Dicot
Eastern prairie fringed orchid	<i>Platanthera leucophaea</i>	Monocot
Harperella	<i>Ptilimnium nodosum</i>	Dicot
Michaux's sumac	<i>Rhus michauxii</i>	Dicot
American chaffseed	<i>Schwalbea americana</i>	Dicot
Houghton's goldenrod	<i>Solidago houghtonii</i>	Dicot
Seabeach amaranth	<i>Amaranthus pumilus</i>	Dicot
Virginia sneezeweed	<i>Helenium virginicum</i>	Dicot
Virginia spiraea	<i>Spiraea virginiana</i>	Dicot
Running buffalo clover	<i>Trifolium stoloniferum</i>	Dicot
Ute ladies'-tresses	<i>Spiranthes diluvialis</i>	Monocot
Leedy's roseroot	<i>Rhodiola integrifolia</i> ssp. <i>leedyi</i>	Dicot
American hart's-tongue fern	<i>Asplenium scolopendrium</i> var. <i>americanum</i>	Ferns
Rock gnome lichen	<i>Gymnoderma lineare</i>	Lichen
Sonoran pronghorn	<i>Antilocapra americana sonoriensis</i>	Mammal
Delmarva Peninsula fox squirrel	<i>Sciurus niger cinereus</i>	Mammal
Florida panther	<i>Puma (=Felis) concolor coryi</i>	Mammal
Jaguar	<i>Panthera onca</i>	Mammal
Mount Graham red squirrel	<i>Tamiasciurus hudsonicus grahamensis</i>	Mammal
New Mexico meadow jumping mouse	<i>Zapus hudsonius luteus</i>	Mammal
Lesser long-nosed bat	<i>Leptonycteris curasoae yerbabuenae</i>	Mammal
Preble's meadow jumping mouse	<i>Zapus hudsonius preblei</i>	Mammal
Hualapai Mexican vole	<i>Microtus mexicanus hualpaiensis</i>	Mammal
Red wolf	<i>Canis rufus</i>	Mammal
California condor	<i>Gymnogyps californianus</i>	Bird
Florida grasshopper sparrow	<i>Ammodramus savannarum floridanus</i>	Bird
Yuma clapper rail	<i>Rallus longirostris yumanensis</i>	Bird
Masked bobwhite (quail)	<i>Colinus virginianus ridgwayi</i>	Bird
California least tern	<i>Sterna antillarum browni</i>	Bird
American crocodile	<i>Crocodylus acutus</i>	Reptile
Atlantic salt marsh snake	<i>Nerodia clarkii taeniata</i>	Reptile

New Mexican ridge-nosed rattlesnake	<i>Crotalus willardi obscurus</i>	Reptile
Bluetail mole skink	<i>Eumeces egregius lividus</i>	Reptile
Bog (=Muhlenberg) turtle	<i>Clemmys muhlenbergii</i>	Reptile
Desert tortoise	<i>Gopherus agassizii</i>	Reptile
Eastern indigo snake	<i>Drymarchon corais couperi</i>	Reptile
Narrow-headed gartersnake	<i>Thamnophis rufipunctatus</i>	Reptile
Northern Mexican gartersnake	<i>Thamnophis eques megalops</i>	Reptile
Cheat Mountain salamander	<i>Plethodon nettingi</i>	Amphibian
Frosted Flatwoods salamander	<i>Ambystoma cingulatum</i>	Amphibian
Jemez Mountains Salamander	<i>Plethodon neomexicanus</i>	Amphibian
Reticulated flatwoods salamander	<i>Ambystoma bishopi</i>	Amphibian
Shenandoah salamander	<i>Plethodon shenandoah</i>	Amphibian
Sonora tiger Salamander	<i>Ambystoma tigrinum stebbinsi</i>	Amphibian
Chiricahua leopard frog	<i>Rana chiricahuensis</i>	Amphibian
Humpback chub	<i>Gila cypha</i>	Fish
Maryland darter	<i>Etheostoma sellare</i>	Fish
Colorado pikeminnow (=squawfish)	<i>Ptychocheilus lucius</i>	Fish
Gila topminnow (incl. Yaqui)	<i>Poeciliopsis occidentalis</i>	Fish
Apache trout	<i>Oncorhynchus apache</i>	Fish
Gila trout	<i>Oncorhynchus gilae</i>	Fish
Greenback Cutthroat trout	<i>Oncorhynchus clarki stomias</i>	Fish
Woundfin	<i>Plagopterus argentissimus</i>	Fish
Diamond Darter	<i>Crystallaria cincotta</i>	Fish
Roanoke logperch	<i>Percina rex</i>	Fish
Bonytail chub	<i>Gila elegans</i>	Fish
Chihuahua chub	<i>Gila nigrescens</i>	Fish
Sonora chub	<i>Gila ditaenia</i>	Fish
Virgin River Chub	<i>Gila semimuda (=robusta)</i>	Fish
Yaqui catfish	<i>Ictalurus pricei</i>	Fish
Gila chub	<i>Gila intermedia</i>	Fish
Yaqui chub	<i>Gila purpurea</i>	Fish
Loach minnow	<i>Tiaroga cobitis</i>	Fish
Desert pupfish	<i>Cyprinodon macularius</i>	Fish
Beautiful shiner	<i>Cyprinella formosa</i>	Fish
Okaloosa darter	<i>Etheostoma okaloosae</i>	Fish
Pecos bluntnose shiner	<i>Notropis simus pecosensis</i>	Fish
Little Colorado spinedace	<i>Lepidomeda vittata</i>	Fish
Razorback sucker	<i>Xyrauchen texanus</i>	Fish
Spikedace	<i>Meda fulgida</i>	Fish
Zuni Bluehead Sucker	<i>Catostomus discobolus yarrowi</i>	Fish
Rio Grande silvery minnow	<i>Hybognathus amarus</i>	Fish

Smalltooth sawfish	<i>Pristis pectinata</i>	Fish
Atlantic Sturgeon (gulf subspecies)	<i>Acipenser oxyrinchus desotoi</i>	Fish
Green blossom (pearlymussel)	<i>Epioblasma torulosa gubernaculum</i>	Bivalve
Tubercled blossom (pearlymussel)	<i>Epioblasma torulosa torulosa</i>	Bivalve
Birdwing pearlymussel	<i>Lemiox rimosus</i>	Bivalve
Rough rabbitsfoot	<i>Quadrula cylindrica strigillata</i>	Bivalve
Chittenango ovate amber snail	<i>Succinea chittenangoensis</i>	Gastropod
Flat-spired three-toothed Snail	<i>Triodopsis platysayoides</i>	Gastropod
Virginia fringed mountain snail	<i>Polygyriscus virginianus</i>	Gastropod
Kanab ambersnail	<i>Oxyloma haydeni kanabensis</i>	Gastropod
Alamosa springsnail	<i>Tryonia alamosae</i>	Gastropod
Chupadera springsnail	<i>Pyrgulopsis chupaderae</i>	Gastropod
Roswell springsnail	<i>Pyrgulopsis roswellensis</i>	Gastropod
Koster's springsnail	<i>Juturnia kosteri</i>	Gastropod
Three Forks Springsnail	<i>Pyrgulopsis trivialis</i>	Gastropod
San Bernardino springsnail	<i>Pyrgulopsis bernardina</i>	Gastropod
Socorro springsnail	<i>Pyrgulopsis neomexicana</i>	Gastropod
Pawnee montane skipper	<i>Hesperia leonardus montana</i>	Insect
Uncompahgre fritillary butterfly	<i>Boloria acrocneuma</i>	Insect
Northeastern beach tiger beetle	<i>Cicindela dorsalis dorsalis</i>	Insect
Puritan tiger beetle	<i>Cicindela puritana</i>	Insect
Hay's Spring amphipod	<i>Stygobromus hayi</i>	Crustacean
Madison Cave isopod	<i>Antrolana lira</i>	Crustacean
Socorro isopod	<i>Thermosphaeroma thermophilus</i>	Crustacean
Noel's Amphipod	<i>Gammarus desperatus</i>	Crustacean
Lee County cave isopod	<i>Lirceus usdagalun</i>	Crustacean
Squirrel Chimney Cave shrimp	<i>Palaemonetes cumingii</i>	Crustacean
Acuna Cactus	<i>Echinomastus erectocentrus</i> var. <i>acunensis</i>	Dicot
Fickeisen Plains cactus	<i>Pediocactus peeblesianus fickeiseniae</i>	Dicot
DeBeque phacelia	<i>Phacelia submutica</i>	Dicot
Sacramento prickly poppy	<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>	Dicot
Sentry milk-vetch	<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>	Dicot
Mancos milk-vetch	<i>Astragalus humillimus</i>	Dicot
Osterhout milkvetch	<i>Astragalus osterhoutii</i>	Dicot
Virginia round-leaf birch	<i>Betula uber</i>	Dicot
Navajo sedge	<i>Carex specuicola</i>	Monocot
Lee pincushion cactus	<i>Coryphantha sneedii</i> var. <i>leei</i>	Dicot
Lewton's polygala	<i>Polygala lewtonii</i>	Dicot
Jones Cycladenia	<i>Cycladenia humilis</i> var. <i>jonesii</i>	Dicot
Nichol's Turk's head cactus	<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>	Dicot
Kuenzler hedgehog cactus	<i>Echinocereus fendleri</i> var. <i>kuenzleri</i>	Dicot

Arizona hedgehog cactus	<i>Echinocereus triglochidiatus</i> var. <i>arizonicus</i>	Dicot
Zuni fleabane	<i>Erigeron rhizomatus</i>	Dicot
Gypsum wild-buckwheat	<i>Eriogonum gypsophilum</i>	Dicot
Penland alpine fen mustard	<i>Eutrema penlandii</i>	Dicot
Brady pincushion cactus	<i>Pediocactus bradyi</i>	Dicot
Knowlton's cactus	<i>Pediocactus knowltonii</i>	Dicot
Peebles Navajo cactus	<i>Pediocactus peeblesianus</i> var. <i>peeblesianus</i>	Dicot
Siler pincushion cactus	<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>	Dicot
North Park phacelia	<i>Phacelia formosula</i>	Dicot
Arizona Cliff-rose	<i>Purshia</i> (= <i>Cowania</i>) <i>subintegra</i>	Dicot
Northeastern bulrush	<i>Scirpus ancistrochaetus</i>	Monocot
Colorado hookless Cactus	<i>Sclerocactus glaucus</i>	Dicot
Mesa Verde cactus	<i>Sclerocactus mesae-verdae</i>	Dicot
San Francisco Peaks ragwort	<i>Packera franciscana</i>	Dicot
Todsen's pennyroyal	<i>Hedeoma todsenii</i>	Dicot
Sandplain gerardia	<i>Agalinis acuta</i>	Dicot
Kearney's blue-star	<i>Amsonia kearneyana</i>	Dicot
Welsh's milkweed	<i>Asclepias welshii</i>	Dicot
Sacramento Mountains thistle	<i>Cirsium vinaceum</i>	Dicot
Cochise pincushion cactus	<i>Coryphantha robbinsorum</i>	Dicot
Pima pineapple cactus	<i>Coryphantha scheeri</i> var. <i>robustispina</i>	Dicot
clay-loving wild buckwheat	<i>Eriogonum pelinophilum</i>	Dicot
Peter's Mountain mallow	<i>Iliamna corei</i>	Dicot
Holmgren milk-vetch	<i>Astragalus holmgreniorum</i>	Dicot
Huachuca water-umbel	<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>	Dicot
Pagosa skyrocket	<i>Ipomopsis polyantha</i>	Dicot
Dudley Bluffs twinpod	<i>Physaria obcordata</i>	Dicot
Shale barren rock cress	<i>Arabis serotina</i>	Dicot
Penland beardtongue	<i>Penstemon penlandii</i>	Dicot
Holy Ghost ipomopsis	<i>Ipomopsis sancti-spiritus</i>	Dicot
Dudley Bluffs bladderpod	<i>Lesquerella congesta</i>	Dicot
Parachute beardtongue	<i>Penstemon debilis</i>	Dicot
Canelo Hills ladies'-tresses	<i>Spiranthes delitescens</i>	Monocot
Gierisch mallow	<i>Sphaeralcea gierischii</i>	Dicot
Aboriginal Prickly-apple	<i>Harrisia aboriginum</i>	Dicot
Apalachicola rosemary	<i>Conradina glabra</i>	Dicot
Avon Park harebells	<i>Crotalaria avonensis</i>	Dicot
Beach jacquemontii	<i>Jacquemontia reclinata</i>	Dicot
Beautiful pawpaw	<i>Deeringothamnus pulchellus</i>	Dicot
Brooksville bellflower	<i>Campanula robinsiae</i>	Dicot
Cape Sable Thoroughwort	<i>Chromolaena frustrata</i>	Dicot
Carter's mustard	<i>Warea carteri</i>	Dicot
Carter's small-flowered flax	<i>Linum carteri carteri</i>	Dicot

Chapman rhododendron	<i>Rhododendron chapmanii</i>	Dicot
Cooley's meadowrue	<i>Thalictrum cooleyi</i>	Dicot
Cooley's water-willow	<i>Justicia cooleyi</i>	Dicot
Crenulate lead-plant	<i>Amorpha crenulata</i>	Dicot
Deltoid spurge	<i>Chamaesyce deltoidea</i> ssp. <i>deltoidea</i>	Dicot
Etonia rosemary	<i>Conradina etonia</i>	Dicot
Florida bonamia	<i>Bonamia grandiflora</i>	Dicot
Florida brickell-bush	<i>Brickellia mosieri</i>	Dicot
Florida golden aster	<i>Chrysopsis floridana</i>	Dicot
Florida semaphore cactus	<i>Consolea corallicola</i>	Dicot
Florida skullcap	<i>Scutellaria floridana</i>	Dicot
Florida ziziphus	<i>Ziziphus celata</i>	Dicot
Four-petal pawpaw	<i>Asimina tetramera</i>	Dicot
Fragrant prickly-apple	<i>Cereus eriophorus</i> var. <i>fragrans</i>	Dicot
Fringed campion	<i>Silene polypetala</i>	Dicot
Garber's spurge	<i>Chamaesyce garberi</i>	Dicot
Garrett's mint	<i>Dicerandra christmanii</i>	Dicot
Gentian pinkroot	<i>Spigelia gentianoides</i>	Dicot
Godfrey's butterwort	<i>Pinguicula ionantha</i>	Dicot
Highlands scrub hypericum	<i>Hypericum cumulicola</i>	Dicot
Key tree cactus	<i>Pilosocereus robinii</i>	Dicot
Lakela's mint	<i>Dicerandra immaculata</i>	Dicot
Longspurred mint	<i>Dicerandra cornutissima</i>	Dicot
Miccosukee gooseberry	<i>Ribes echinellum</i>	Dicot
Okeechobee gourd	<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>	Dicot
Papery whitlow-wort	<i>Paronychia chartacea</i>	Dicot
Pigeon wings	<i>Clitoria fragrans</i>	Dicot
Pygmy fringe-tree	<i>Chionanthus pygmaeus</i>	Dicot
Roan Mountain Bluet	<i>Hedyotis purpurea</i> var. <i>montana</i>	Dicot
Rugel's pawpaw	<i>Deeringothamnus rugelii</i>	Dicot
Sandlace	<i>Polygonella myriophylla</i>	Dicot
Scrub blazingstar	<i>Liatris ohlingerae</i>	Dicot
Scrub buckwheat	<i>Eriogonum longifolium</i> var. <i>gnaphalifolium</i>	Dicot
Scrub lupine	<i>Lupinus aridorum</i>	Dicot
Scrub mint	<i>Dicerandra frutescens</i>	Dicot
Scrub plum	<i>Prunus geniculata</i>	Dicot
Short-leaved rosemary	<i>Conradina brevifolia</i>	Dicot
Small's milkpea	<i>Galactia smallii</i>	Dicot
Snakeroot	<i>Eryngium cuneifolium</i>	Dicot
Telephus spurge	<i>Euphorbia telephioides</i>	Dicot
Tiny polygala	<i>Polygala smallii</i>	Dicot
White birds-in-a-nest	<i>Macbridea alba</i>	Dicot
Wide-leaf warea	<i>Warea amplexifolia</i>	Dicot

Wireweed	<i>Polygonella basiramia</i>	Dicot
Bartram's Hairstreak Butterfly	<i>Strymon acis bartrami</i>	Insect
Florida Leafwing Butterfly	<i>Anaea troglodyta floridalis</i>	Insect
Miami Blue Butterfly	<i>Cyclargus (=Hemiargus) thomasi bethunebakeri</i>	Insect
Schaus swallowtail butterfly	<i>Heraclides aristodemus ponceanus</i>	Insect
Florida perforate cladonia	<i>Cladonia perforata</i>	Lichen
Anastasia Island beach mouse	<i>Peromyscus polionotus phasma</i>	Mammal
Choctawhatchee beach mouse	<i>Peromyscus polionotus allophrys</i>	Mammal
Florida Bonneted bat	<i>Eumops floridanus</i>	Mammal
Florida salt marsh vole	<i>Microtus pennsylvanicus dukecampbelli</i>	Mammal
Key deer	<i>Odocoileus virginianus clavium</i>	Mammal
Key Largo cotton mouse	<i>Peromyscus gossypinus allapaticola</i>	Mammal
Key Largo woodrat	<i>Neotoma floridana smalli</i>	Mammal
Lower Keys marsh rabbit	<i>Sylvilagus palustris hefneri</i>	Mammal
Perdido Key beach mouse	<i>Peromyscus polionotus trissyllepsis</i>	Mammal
Rice rat	<i>Oryzomys palustris natator</i>	Mammal
Southeastern beach mouse	<i>Peromyscus polionotus niveiventris</i>	Mammal
St. Andrew beach mouse	<i>Peromyscus polionotus peninsularis</i>	Mammal
West Indian Manatee	<i>Trichechus manatus latirostris</i>	Mammal
Audubon crested caracara	<i>Polyborus plancus audubonii</i>	Bird
Cape Sable seaside sparrow	<i>Ammodramus maritimus mirabilis</i>	Bird
Everglade snail kite	<i>Rostrhamus sociabilis plumbeus</i>	Bird
Florida scrub-jay	<i>Aphelocoma coerulescens</i>	Bird
Kirtland's Warbler	<i>Setophaga kirtlandii</i>	Bird
Wood stork	<i>Mycteria americana</i>	Bird
Bachman's warbler (=wood)	<i>Vermivora bachmanii</i>	Bird
Sand skink	<i>Neoseps reynoldsi</i>	Reptile
Stock Island tree snail	<i>Orthalicus reses (not incl. nesodryas)</i>	Gastropod
Britton's beargrass	<i>Nolina brittoniana</i>	Monocot
Harper's beauty	<i>Harperocallis flava</i>	Monocot
Johnson's seagrass	<i>Halophila johnsonii</i>	Monocot
Knieskern's Beaked-rush	<i>Rhynchospora knieskernii</i>	Monocot
Florida torreyia	<i>Torreya taxifolia</i>	Conf/cycds
Elkhorn coral	<i>Acropora palmate</i>	Coral
Staghorn coral	<i>Acropora cervicornis</i>	Coral

Appendix 2

Listed Species Rationale for NO Effects When Action Area is Limited to Treated Agricultural Filed by Assumed Mitigation for Spray Drift

The spray drift (in-field buffer) and rainfast mitigations discussed in the cotton section 3 ecological risk assessment (D404823), the concurrently issued soybean addendum (D426789) and at the beginning of this assessment are anticipated to restrict dicamba and DCSA residues above any threshold toxicity values to the agricultural field. Therefore, the following table describes the habitat and rationale for all listed species that were determined to not use cotton and soybean fields or resources that may overlap with dicamba DGA uses.

Species	Habitat	Rationale	Source
Terrestrial Animals			
Anastasia Island beach mouse <i>(Peromyscus polionotus phasma)</i>	Primarily located on coastal sand dunes, coastal scrub, sandy areas, and inland wood vegetation. The species occupy both frontal (primary and secondary) and scrub dunes. Habitat size is 3-14 linear miles of beach. Young beach mice move an average of 432 m (1,415 ft) before establishing a home range. Elevated coastal scrub provides refugia from storms.	The proposed uses of dicamba DGA are not expected to overlap with scrub, beach, dune or woody habitat.	US FWS. 1993. Recovery Plan for the Anastasia Island and Southeastern Beach Mouse. Atlanta Georgia. 30 pp. http://ecos.fws.gov/docs/recovery_plan/930923b.pdf . US FWS. 2007. Anastasia Island beach mouse <i>(Peromyscus polionotus phasma)</i> , 5-Year Review: Summary and Evaluation. Jacksonville, Florida. 25 pp. http://ecos.fws.gov/docs/five_year_review/doc1086.pdf .
Bachman's warbler <i>(Vermivora bachmanii)</i>	Breeds in palustrine forested wetlands; seen near longleaf pine forest near brackish marsh. (USFWS 2007)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2007. Five Year Review: http://ecos.fws.gov/docs/five_year_review/doc1037.pdf
Bartram's Hairstreak Butterfly, <i>(Strymon acis bartrami)</i>	Mostly occur within pine rocklands, specifically those that retain their mutual and sole host plant, pineland croton. Adult butterflies will also make use of rockland hammock and hydric pine flatwood vegetation when interspersed within the pine rockland habitat.	The proposed uses of dicamba DGA are not expected to overlap with pine rockland habitat.	US FWS. 2014. Endangered Status for the Florida Leafwing and Bartam's Scrub-Hairstreak Butterflies. http://www.gpo.gov/fdsys/pkg/FR-2014-08-12/pdf/2014-18614.pdf
Black-footed ferret <i>(Mustela nigripes)</i>	The black-footed ferret relies on prairie dog colonies for both food and shelter.	The proposed dicamba DGA uses are not expected to overlap with prairie dog colonies.	USFWS. 2008. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2364.pdf

Butterfly, Karner blue (<i>Lycaeides melissa samuelis</i>)	Habitat is successional areas with wild lupines, such as open areas in and near forest stands, along with old fields, highway and powerline rights-of-way, and remnant barrens and savannas, having a broken or scattered tree or tall shrub canopy (US FWS, 2003. pp.28-30)	The proposed dicamba DGA uses are not expected to overlap with successional areas with lupines or other wildflowers.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030919.pdf
Butterfly, Mitchell's satyr (<i>Neonympha mitchellii mitchellii</i>)	Mitchell's satyr habitat is best characterized as a sedge-dominated fen community; Known habitats are all peatlands but range along a continuum from prairie/bog fen to sedge meadow/swamp. However, certain attributes at each site remain fairly constant. All historical and active habitats have a herbaceous community which is dominated by sedges, usually <i>Carex stricta</i> , with scattered deciduous and/or coniferous trees, most often <i>L. laricina</i> or <i>Juniperus virginiana</i> (red cedar) (US FWS 1998, pp. 11-12).	The proposed dicamba DGA uses are not expected to overlap with wetlands or areas with sedge communities.	USFWS 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980402.pdf
Cape Sable seaside sparrow (<i>Ammodramus maritimus mirabilis</i>)	Species habitat consists of short hydroperiod prairie, freshwater to brackish marshes, mixed marl prairie community that often includes muhly grass (<i>Muhlenbergia filipes</i>). These short-hydroperiod prairies contain moderately dense, clumped grasses, with open space permitting ground movements by the sparrows. Sparrows tend to avoid tall, dense, saw- grass-dominated communities, spike-rush (<i>Eleocharis sp.</i>) marshes, extensive cattail (<i>Typha sp.</i>) monocultures, long-	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats and open areas. Agricultural field monocultures are not expected to provide adequate habitat for the sparrow.	US FWS. 1999. South Florida multiple-species recovery plan. Available on FWS website. http://ecos.fws.gov/docs/recovery_plan/140903.pdf http://www.fws.gov/southeast/vbpdfs/species/birds/csss.pdf

	hydroperiod wetlands with tall, dense vegetative cover, and sites supporting woody vegetation. Cape Sable seaside sparrows avoid sites with permanent water cover.		
Carolina northern flying squirrel (<i>Glaucomys sabrinus coloratus</i>)	Species composition of the occupied forest may vary in different locations, some combination of hardwoods and conifers (particularly spruce and fir) appears essential to support these animals...Food sources for the Carolina northern flying squirrel include fungi, lichens, staminate cones, insects, and other animal matter (US FWS 1990, p. 6-7)	The proposed dicamba DGA uses are not expected to overlap with hardwood and conifer forests.	USFWS. 1990. Recovery Plan for Appalachian Northern Flying Squirrels. United States Fish and Wildlife Service.
Chittenango ovate amber snail (<i>Succinea chittenangoensis</i>)	Habitat is in a ravine at the base of the 167-foot-tall waterfall formed by Chittenango Creek. The snail requires cool to mild-temperature, moist conditions provided by the waterfalls and mist in its environment. The base of the waterfall, and the ledges where it is found comprise an early successional sere that is periodically rejuvenated to a bare substrate by floodwaters. Seems to prefer green vegetation such as the various mosses, liverworts, and other low herbaceous vegetation found within the spray zone adjacent to the Falls (US FWS 2006.	The proposed uses of dicamba DGA are not expected to overlap with waterfall habitat.	US FWS. 2006. Recovery Plan for the Chittenango Ovate Amber Snail http://ecos.fws.gov/docs/recovery_plan/060823.pdf
Choctawhatchee beach mouse (<i>Peromyscus polionotus alloparys</i>)	The beach mouse inhabits coastal sand dunes and coastal scrub; primary, secondary, and interior or scrub dunes (vegetation includes sea oats, grasses, woody goldenrod, false rosemary, scrub oaks, and yaupon holly). Approximately 2,500 acres of	The proposed uses of dicamba DGA are not expected to overlap with sand dune and coastal scrub habitat.	US FWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. http://ecos.fws.gov/docs/recovery_plan/870812.pdf .

	habitat separated into four populations.		US FWS. 2007. Choctawhatchee Beach Mouse (<i>Peromyscus polionotus alloparys</i>), 5-Year Review: Summary and Evaluation. Panama City, Florida. 25 pp. http://ecos.fws.gov/docs/five_year_review/doc1081.pdf .
Everglade snail kite <i>(Rostrhamus sociabilis plumbeus)</i>	Located on wetlands, lowland freshwater marshes, and shallow vegetated edges of lakes (natural and manmade). Range restricted to the watersheds of the Everglades, Lake Okeechobee and Kissimmee, and Upper St. John River.	The proposed uses of dicamba DGA are not expected to overlap with wetland habitat	US FWS. 1999. South Florida multiple-species recovery plan. http://ecos.fws.gov/docs/recovery_plan/140903.pdf http://www.fws.gov/verobeach/MSRPPDFs/EvergladeSnailKite.pdf
Flat-spined three-toothed Snail <i>(Triodopsis platysayoides)</i>	Found in cool, moist, deep fissures in shale, sandstone, and limestone outcrops and in talus. Outcrops of rock more than one meter high are considered potential habitat if they contain cracks and crevices at least one meter deep. Rock structure is more important than the age and type of trees growing on rock. At night, the species has been observed foraging and resting under wet leaves, next to rock structures.	The proposed uses of dicamba DGA are not expected to overlap with rock outcrops.	US FWS. 2007. Flat-spined Three-Toothed Snail (<i>Triodopsis platysayoides</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1172.pdf
Florida Bonneted bat <i>(Eumops floridanus)</i>	Habitat mainly consists of foraging areas and roosting sites, including artificial structures. Open, fresh water and wetlands provide prime foraging areas for bats.	The proposed uses of dicamba DGA are not expected to overlap with wetland and other aquatic habitats.	US FWS. 2013. Endangered Species Status for the Florida Bonneted Bat. http://www.gpo.gov/fdsys/pkg/FR-2013-10-02/pdf/2013-23401.pdf
Florida Leafwing Butterfly <i>(Anaea troglodyta floralis)</i>	Mostly occur within pine rocklands, specifically those that retain their mutual and sole host plant, pineland croton. Adult butterflies will also make use of rockland hammock and hydric pine flatwood vegetation when interspersed within the pine rockland habitat.	The proposed uses of dicamba DGA are not expected to overlap with pine rockland and other rocky or woody habitats.	US FWS. 2014. Endangered Status for the Florida Leafwing and Bartam's Scrub-Hairstreak Butterflies. http://www.gpo.gov/fdsys/pkg/FR-2014-08-12/pdf/2014-18614.pdf
Florida salt marsh vole	Located on salt marsh habitats dominated by salt grass (<i>Distichlis spicata</i>), but may also contain smooth cordgrass (<i>Spartina</i>	The proposed uses of dicamba DGA are not expected to overlap with salt marsh habitats.	US FWS. 1997. Recovery plan for the Florida salt marsh vole. U.S. Fish and Wildlife Service, Atlanta Georgia. 9pp.

<i>(Microtus pennsylvanicus dukecampbelli)</i>	<i>alterniflora</i>) and glasswort (<i>Salicornia</i> spp.) vegetation. Dense ground-level vegetation is common. Estimated home range is 804 square meters.		http://ecos.fws.gov/docs/recovery_plan/970930d.pdf .
Florida scrub-jay <i>(Aphelocoma coerulescens)</i>	Habitat is mostly scrub communities (primarily oak scrub) with fine, white, drained sand. Currently only occurs in scattered and often small patches in peninsular Florida.	The proposed uses of dicamba DGA are not expected to overlap with scrubland habitats.	US FWS. 1990. Recovery Plan for the Florida Scrub Jay. http://ecos.fws.gov/docs/recovery_plan/900509.pdf
Frosted Flatwoods salamander <i>(Ambystoma cingulatum)</i>	Fire-maintained, open-canopied, flatwoods and savannas dominated by longleaf pine (<i>Pinus palustris</i>), with naturally occurring slash pine (<i>P. ellioti</i>) in wetter areas. Adults spend most of their lives underground. Breed in small, isolated ephemeral ponds (USFWS 2009)	The proposed dicamba DGA uses are not expected to overlap with flatwoods or savannas.	USFWS 2009. Federal Register, vol. 74, No. 62. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
<u>Bat, gray (Myotis grisescens)</u>	Gray bats are year round cave dwellers, although they may also use mines. They hibernate from as late as November 10 to late March or early April. At other times, they forage from late afternoon through early morning within 12-20 miles of their caves, most often within 4 miles of their caves. Foraging habitat is strongly correlated with open waters (rivers, lakes, reservoirs) (US FWS, 2009, pp. 6-7). Historically, rivers near caves provided both foraging habitat and riparian tree vegetation that provided cover. Small	The proposed dicamba DGA uses are not expected to encompass caves or the forest/open water areas where bats forage.	USFWS. 1982. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/820701.pdf USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc2625.pdf

	lakes and reservoirs where cover is not too distant also provide foraging habitat. Bats will opportunistically forage in riparian and upland areas, particularly when migrating (US FWS, 1982. pp. 6-7).		
Key deer <i>(Odocoileus virginianus clavium)</i>	Habitat consists of pine flatwoods, pine rocklands, hardwood hammocks, buttonwood wetlands, mangrove wetlands, and freshwater wetlands.	The proposed uses of dicamba DGA are not expected to overlap with wetland, woodland or rocky habitats.	US FWS. 1999. South Florida multi-species recovery plan, Florida. United States Fish and Wildlife Service. http://www.fws.gov/verobeach/MSRPPDFs/KeyDeer.pdf .
Key Largo cotton mouse <i>(Peromyscus gossypinus allapaticola)</i>	Tropical hardwood hammock; upland forest; tall canopy (average 9.8 m) and an open understory; canopy trees include black ironwood (<i>Krugiodendron ferreum</i>), gumbo limbo (<i>Bursera simaruba</i>) Jamaican dogwood (<i>Piscidia piscipula</i>), mahogany (<i>Swietenia mahagani</i>), pigeon plum (<i>Coccoloba diversifolia</i>), poisonwood (<i>Metopium toxiferum</i>), trangler fig (<i>Ficus aurea</i>), and wild tamarind (<i>Lysiloma latisiliquum</i>). Hammock understory contains torchwood (<i>Amyris elemifera</i>), milkbark (<i>Drypetes diversifolia</i>), wild coffee (<i>Psychotria nervosa</i>), marlberry (<i>Aroisia escallonioides</i>), stoppers (<i>Eugenia</i> spp.), soldierwood (<i>Colubrina elliptica</i>), crabwood (<i>Gymnanthes lucida</i>), and velvetseed (<i>Guettarda scabra</i>); ground cover contains cheese shrub (<i>Morinda royoc</i>) and snowberry (<i>Chicocoea alba</i>); adjacent <i>Salicornia</i> coastal strands, recently burned fern-dominated (<i>Pteridium aquilinum</i>) areas.	The proposed uses of dicamba DGA are not expected to overlap with wooded habitats.	US FWS. 2009. Key Largo Cotton Mouse (<i>Peromyscus gossypinus allapaticola</i>), 5-Year Review: Summary and Evaluation. Vero Beach, Florida. 19 pp. http://ecos.fws.gov/docs/five_year_review/doc2378.pdf . US FWS. 1999. Key Largo Cotton Mouse in South Florida Multi-Species Recovery Plan. Atlanta, Georgia. pgs. 4-79 - 4-95. 2172 pp. http://www.fws.gov/verobeach/MSRPPDFs/KeyLargoCottonmouse.pdf ; http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf .

Key Largo woodrat <i>(Neotoma floridana smalli)</i>	Habitat consists of tropical hardwood hammocks; mature and younger hardwood hammocks, as well as disturbed areas adjacent to mature hammocks.	The proposed uses of dicamba DGA are not expected to overlap with wooded habitats.	US FWS. 1999. Key Largo Woodrat (<i>Neotoma floridana smalli</i>) in South Florida Multi-Species Recovery Plan. Atlanta, Georgia. pgs. 4-195 - 4-216. 2172 pp. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf http://www.fws.gov/verobeach/MSRPPDFs/KeyLargoWoodrat.pdf
Kirtland's Warbler (<i>Setophaga kirtlandii</i>)	Kirtland's warblers generally occupy jack pine stands that are 5-23 years old and at least 30 acres in size. Stands with less than 20% canopy over are rarely used for nesting. Occupied stands usually occur on dry, excessively drained and nutrient poor glacial outwash sands. They are structurally homogenous with trees ranging from 1.7-5.0 m in height (US FWS, 2012, p. 24). Species is migratory and mobile species and breeding areas are found in Wisconsin.	The proposed dicamba DGA salt uses are not expected to overlap with jack pine stands.	USFWS. 2012. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc4045.pdf
Lower Keys marsh rabbit <i>(Sylvilagus palustris hefneri)</i>	Found in salt marshes, freshwater bordered with hammocks and flatwoods; transition zone on grasses and sedges, grassy marshes and prairies; coastal berm. Species occasionally use low shrub marshes and mangrove communities; salt marsh-butonwood transition zones, freshwater wetlands; upland pinelands and hammocks.	The proposed uses of dicamba DGA are not expected to overlap with wetland or wooded habitats.	US FWS. 1999. Lower Keys Rabbit (<i>Sylvilagus palustris hefneri</i>) in South Florida Multi-Species Recovery Plan. Atlanta, Georgia. pgs. 4-151 - 4-172. 2172 pp. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf ; and http://www.fws.gov/southeast/vbpdfs/species/mammals/lkmr.pdf US FWS. 2007. Lower Keys Rabbit (<i>Sylvilagus palustris hefneri</i>) 5-Year review: Summary and Evaluation. Vero Beach, Florida. http://ecos.fws.gov/docs/five_year_review/doc1110.pdf US FWS. 1990. Endangered and Threatened Wildlife and Plants; Endangered Status for

			<p>the Lower Keys Rabbit and Threatened Status for the Squirrel Chimney Cave Shrimp. Federal Register Vol. 55, No. 120, June 21, 1990. pgs 25588-25591.</p> <p>http://ecos.fws.gov/docs/federal_register/fr1715.pdf</p>
<p>Lesser long-nosed bat (<i>Leptonycteris curasoae yerbabuenae</i>)</p>	<p>The bat has evolved an apparent mutualistic association with columnar cacti <i>Agave</i> sp. The bat is principally a nectar feeder, foraging on the flowers of <i>Agave</i>, and in some minor proportions consuming the pollen, fruits, and any incidental insects associated with the flowers. The bat uses caves and mines as day roosts.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with the caves and mines the bat uses as day roosts and The bat's major resource need, <i>Agave</i> plants are not expected to be on soybean and cotton fields.</p>	<p>USFWS. 1995. Recovery Plan.</p> <p>http://ecos.fws.gov/docs/recovery_plan/970304.pdf</p>
<p>Mexican spotted owl (<i>Strix occidentalis lucida</i>)</p>	<p>Forest and canyonlands in SW U.S. (USFWS 2011, p. 7).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with forests or Canyonlands.</p>	<p>USFWS 2011. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/FR00000557-%20BP031995%20Draft%20MSO%20Recovery%20Plan%20First%20Revision.pdf</p>
<p>Miami Blue Butterfly</p> <p>(<i>Cyclargus</i> (= <i>Hemiargus</i>) <i>thomasi bethunebakeri</i>)</p>	<p>Species is a coastal butterfly reported to occur in openings and around the edges of hardwood hammocks (forest habitats characterized by broad-leaved evergreens), and in other communities adjacent to the coast that are prone to frequent disturbances (e.g., coastal berm hammocks, dunes, and scrub).</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with wooded, coastal or scrubland habitats.</p>	<p>US FWS. 2012. Listing of the Miami Blue Butterfly as Endangered Throughout its Range: Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly in Coastal South and Central Florida: Final rule.</p> <p>http://www.gpo.gov/fdsys/pkg/FR-2012-04-06/pdf/2012-8088.pdf</p>
<p>Kanab ambersnail (<i>Oxyloma haydeni kanabensis</i>)</p>	<p>The known Kanab ambersnail populations generally occur within habitat conditions described as marshes and other wetlands watered by springs and seeps at the base of sandstone or limestone cliffs.</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.</p>	<p>US FWS. 2011. Kanab ambersnail (<i>Oxyloma haydeni kanabensis</i>) 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3885.pdf</p>

	The sites this snail is found (Three Lakes and Vasey's Paradise), vary in their vegetation distribution and water flow, with the Three Lakes site being more of a marsh habitat, while the Vasey's Paradise site is a cool dolomitic spring habitat.		
Virginia fringed mountain snail (<i>Polygyriscus virginianus</i>)	Usually in areas where limestone is mixed with clay soil and is associated with permanently damp rock fragments and angular limestone pieces. These areas are heavily shaded and may be overgrown with honeysuckle. Living individuals occur in the soil at depths of four to twenty-four inches. Live snails have never been observed on the soil surface	The proposed uses of dicamba DGA are not expected to overlap with limestone outcrops.	US FWS species life-history profile http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=G00Z#lifeHistory
Narrow-headed gartersnake (<i>Thamnophis rufipunctatus</i>)	PCE's are: 1) stream habitat 2) up to 600 ft space on either side of bankful stage river w/ sufficient structural characteristics to support life-history functions, 3) prey base of fish, 4) absence or low levels only of nonnative sunfish and catfish, bullfrogs and/or crayfish.	The proposed uses of dicamba DGA are not expected to overlap with stream or floodplain habitats.	USFWS 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Federal Register V78(132): 41550—41608 http://www.gpo.gov/fdsys/pkg/FR-2013-07-10/pdf/2013-16520.pdf
New Mexico meadow jumping mouse (<i>Zapus hudsonius luteus</i>)	PCE's are: 1) riparian communities along rivers, streams, springs and wetlands, 2) flowing water that provides saturated soils supporting tall herbaceous vegetation comprised mostly of sedges and forbs, sufficient areas along a stream, ditch or canal that contain suitable habitat, adjacent floodplain and upland areas extending ~100m from water's edge.	The proposed uses of dicamba DGA are not expected to overlap with riparian communities and saturated soils.	USFWS, 2013. Endangered and Threatened Wildlife and Plants; Proposed Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse. Federal Register V78(119): 37328—37363 http://www.gpo.gov/fdsys/pkg/FR-2013-06-20/pdf/2013-14366.pdf
Northeastern beach tiger beetle (<i>Cicindela dorsalis dorsalis</i>)	Open sand flats, dunes, water edges, beaches, woodland paths, and sparse grassy areas. Maryland (Calvert and Tangier Sound counties); Massachusetts (Coastal Massachusetts and	The proposed uses of dicamba DGA are not expected to overlap with beach habitats.	US FWS. 1994. Recovery Plan for Northeastern Beach Tiger Beetle http://ecos.fws.gov/docs/recovery_plan/940929b.pdf

	Islands); Virginia (Eastern Shore and Western Shore)		
Northern Mexican gartersnake (<i>Thamnophis eques megalops</i>)	PCE's are: 1) aquatic or riparian habitat, 2) up to 600 ft space on either side of bankful stage river w/ sufficient structural characteristics to support life-history functions 3) prey base of native amphibians and fish and 4) absence or low levels only of nonnative sunfish and catfish, bullfrogs and/or crayfish.	The proposed uses of dicamba DGA are not expected to overlap with stream or floodplain habitats	USFWS 2013. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake. Federal Register V78(132): 41550—41608 http://www.gpo.gov/fdsys/pkg/FR-2013-07-10/pdf/2013-16520.pdf
Pawnee montane skipper (<i>Hesperia leonardus montana</i>)	The skippers occur in Colorado (Teller, Park, Jefferson, and Douglas) in dry, open, Ponderosa pine woodlands where the slopes are moderately steep with soils derived from Pikes Peak granite. The understory is limited in the pine woodlands.	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 1998. Recovery Plan for Pawnee Montane Skipper http://ecos.fws.gov/docs/recovery_plan/980921.pdf
Perdido Key beach mouse (<i>Peromyscus polionotus trissyllepsis</i>)	Coastal sand dunes & coastal scrub (USFWS 1987, p. 2); primary, secondary and interior or scrub dunes (USFWS 2007, p. 9)	The proposed dicamba DGA uses are not expected to overlap with sand dunes or coastal scrub.	USFWS. 1987. Recovery plan for the Choctawhatchee, Perdido Key and Alabama Beach Mouse. U.S. Fish and Wildlife Service, Atlanta, Georgia. 45 pp. Available online at: http://ecos.fws.gov/docs/recovery_plan/870812.pdf . USFWS. 2007. Perdido Key Beach Mouse (<i>Peromyscus polionotus trissyllepsis</i>), 5-Year Review: Summary and Evaluation. Panama City, Florida. 24 pp. Available online at: http://ecos.fws.gov/docs/five_year_review/doc1081.pdf .
Piping plover, Great Lakes watershed (<i>Charadrius melodus</i>)	The breeding habitat of the Great Lakes DPS of the piping plover is well defined by the Critical Habitat designation. Critical Habitat for this	The proposed dicamba DGA uses are not expected to overlap with sparsely vegetated sandy	USFWS. 2009. 5-Year Review. http://ecos.fws.gov/docs/five_year_review/doc3009.pdf

	DPS consists of approximately 200 miles of Great Lakes shoreline (extending 1640 ft inland) in 26 counties in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. Additional Critical Habitat for wintering populations of this DPS are in the southeastern United States and other areas that are outside the scope of this analysis (USFWS, 2000; USFWS, 2009, p.2).	shorelines or islands of the Great Lakes.	USFWS. 2000. Federal Register Notice http://ecos.fws.gov/docs/federal_register/fr3648.pdf
Piping plover, except Great Lakes watershed (<i>Charadrius melodus</i>)	The northern Great Plains DPS of the piping plover utilizes four types of habitats for breeding: alkali lakes and wetlands, inland lakes (Lake of the Woods), reservoirs, and rivers. Most breeding occurs along alkali lakes and wetlands, where nesting sites are generally wide, gravelly, salt encrusted beaches with minimal vegetation. At inland lakes, they use barren to sparsely vegetated islands, beaches, and peninsulas. Sparsely vegetated sandbars and reservoir shorelines are preferred in riverine systems (US FWS, 2002, p. 57640).	The proposed dicamba DGA uses are not expected to overlap with shorelines, beaches, and sandbars of rivers and alkali wetlands.	USFWS. 2002. Federal Register Notice. http://ecos.fws.gov/docs/federal_register/fr3943.pdf
Puritan tiger beetle (<i>Cicindela puritana</i>)	The Maryland population (Calvert, Kent and Cecil Counties) is found in deep burrows, which they dig in sandy deposits on non-vegetated portions of the bluff face. The Connecticut population (Hartford; middlesex) is found in burrows among scattered	The proposed uses of dicamba DGA are not expected to overlap with beach habitats.	US FWS. 1993. Recovery Plan for the Puritan Tiger Beetle http://ecos.fws.gov/docs/recovery_plan/930929a.pdf

	herbaceous vegetation at the upper portions of sandy beaches and occasionally near the water's edge.		
Uncompahgre fritillary butterfly (<i>Boloria acrocnema</i>)	All colonies known to FWS occur in alpine environments, within large patches of snow willow and on northeast facing slopes.	The proposed uses of dicamba DGA are not expected to overlap with alpine habitats.	US FWS. 1994. Recovery Plan for <i>Boloria acrocnema</i> http://ecos.fws.gov/docs/recovery_plan/940317.pdf
Bluetail mole skink (<i>Eumeces egregius lividus</i>)	Habitat is primarily xeric (dry) upland communities above 30 m. The species relies on soils that have few root structures and sparse stands of vegetation but a large amount of debris providing shelter. These attributes are not consistent with cultivated row crop fields.	The proposed dicamba DGA use sites are not expected to provide appropriate habitat.	US FWS. 1999. Multi-Species Recovery Plan for South Florida: Bluetail Mole Skink. United States Fish and Wildlife Service. http://www.fws.gov/verobeach/MSRPPDFs/BluetailMoleSkink.pdf
Bog (=Muhlenberg) turtle (<i>Clemmys muhlenbergii</i>)	Wetland habitats including dry, wet, and periodically flooded micro-habitats and are often interspersed with agricultural areas and livestock grazing.	The proposed dicamba DGA uses are not expected to overlap with aquatic habitats.	US FWS. 2001. Recovery Plan for the Bog Turtle. http://ecos.fws.gov/docs/recovery_plan/010515.pdf
Cheat Mountain salamander (<i>Plethodon nettingi</i>)	This species occurs in red spruce and mixed deciduous forests. Microhabitats have high humidity, moist soil and cool temperatures. The forest floor is (usually) covered with liverwort (<i>Bazzania trilobata</i>) and contains rocks.	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 1991. Cheat Mountain salamander (<i>Plethodon nettingi</i>) recovery plan. United States Fish and Wildlife Service. http://ecos.fws.gov/docs/recovery_plan/910725.pdf USFWS. 2009. Cheat Mountain salamander (<i>Plethodon nettingi</i>) 5-year review: summary and evaluation. http://ecos.fws.gov/docs/five_year_review/doc3267.pdf .

Chiricahua leopard frog (<i>Rana chiricahuensis</i>)	Adults are primarily aquatic and found in a variety of aquatic habitats including cienegas, springs, pools, cattle tanks, lakes, reservoirs, streams, and rivers. The species also requires permanent or semi-permanent pools for breeding, water characterized by low levels of contaminants and moderate pH, and may be excluded or exhibit periodic die-offs where a pathogenic chytridiomycete fungus is present	The proposed uses of dicamba DGA are not expected to overlap with aquatic habitats.	US FWS. 2007. Chiricahua leopard frog (<i>Rana chiricahuensis</i>) final recovery plan. http://ecos.fws.gov/docs/recovery_plan/070604_v3.pdf .
Desert tortoise (<i>Gopherus agassizii</i>)	<p>The Mojave population of the desert tortoise is most commonly found within the desert scrub vegetation type, primarily in creosote bush-scrub vegetation, but also in succulent scrub, cheesebush scrub, blackbush scrub, hopsage scrub, shadscale scrub, microphyll woodland, and Mojave saltbush-allscale scrub. Within the desert microphyll woodland, the desert tortoise occurs in blue palo verde-ironwood-smoke tree woodland. The desert tortoise also occurs in scrub-steppe vegetation types of the desert and semidesert grassland complex.</p> <p>Within these vegetation types, desert tortoises potentially can survive and reproduce where their basic habitat requirements are met. These requirements include a sufficient amount and quality of forage species; shelter sites for protection from predators and environmental extremes; suitable substrates for burrowing, nesting, and overwintering; various plants for shelter; and adequate area for movement, dispersal, and gene flow.</p>	The proposed uses of dicamba DGA are not expected to overlap with the scrub-steppe vegetation types of the desert and semidesert grassland complex (Mojave population) or the steep rocky slopes, drought resistant scrub and tree habitat (Sonoran population) and the agricultural fields where it will be used are not expected to provide the soil and understory requirements of this species.	<p>US FWS, 2011. Revised Recovery Plan for the Mojave Population of the Desert Tortoise (<i>Gopherus agassizii</i>).</p> <p>http://ecos.fws.gov/docs/recovery_plan/RRP%20for%20the%20Mojave%20Desert%20Tortoise%20-%20May%202011_1.pdf</p> <p>US FWS, 1994. Determination of Critical Habitat for the Mojave Population of the Desert Tortoise.</p> <p>http://ecos.fws.gov/docs/federal_register/fr2519.pdf</p>

	In the Sonoran Desert, tortoises tend to inhabit bajadas (slopes at the base of a mountain) and steep, rocky slopes and are not common in the valleys) and are also found in the Sinaloan thornscrub, where vegetation is dominated by drought-resistant shrubs and deciduous trees.		
Jemez Mountains Salamander (<i>Plethodon neomexicanus</i>)	The strictly terrestrial Jemez Mountains salamander predominantly inhabits mixed-conifer forest, consisting primarily of Douglas fir, blue spruce, Engelman spruce, white fir, limber pine, Ponderosa pine, Rocky Mountain maple, and aspen (<i>Populus tremuloides</i>). Pure stands of Ponderosa pine, fir and aspen stands, and high-elevation meadows are not considered ideal habitats but species have been known to occur in such places.	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS species life-history profile. ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=D019#lifeHistory
Red-cockaded entire woodpecker (<i>Picoides borealis</i>)	Habitat: Forest, Savannah (open pine woodlands and savannas with large old pines) (US FWS 2003, p. x) Habitat size (home range): 116 – 357 acres (US FWS 2003, p. 49)	Proposed dicamba DGA uses are not expected to overlap with forest or savannah.	USFWS. 2003. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/030320_2.pdf
Reticulated flatwoods salamander (<i>Ambystoma bishopi</i>)	Aquatic and terrestrial. Longleaf pine ecosystems (Coastal Plain in what were historically longleaf pine-wiregrass flatwoods and savannas). Adults spend most of their lives underground.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2009. Federal Register, vol. 74, No. 26. 50 CFR 17. Endangered and threatened wildlife and plants; determination of endangered status of reticulated flatwoods salamander; designation of critical habitat for frosted flatwoods salamander and

	Breed in small, isolated ephemeral ponds. (USFWS 2009)		reticulated flatwoods salamander. United States Fish and Wildlife Service. Available on line at: http://www.gpo.gov/fdsys/pkg/FR-2009-02-10/pdf/E9-2403.pdf#page=1
Rice rat <i>(Oryzomys palustris natator)</i>	Found in scrub and fringe mangrove communities. Live on small wetland islands, 23 ha.	The proposed uses of dicamba DGA are not expected to overlap with wetland or scrubland habitats.	US FWS. 1999. South Florida multiple-species recovery plan. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf http://ecos.fws.gov/docs/recovery_plan/140903.pdf
Roseate tern <i>(Sterna dougallii dougallii)</i>	Rocky offshore islands with sparse vegetation; although Northeastern Roseate tern nest under vegetation or some other shelter (USFWS 1993, p. 3).	The proposed dicamba DGA uses are not expected to overlap with offshore islands.	USFWS 1993. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plan/930924_v2.pdf
Sand skink <i>(Neoseps reynoldsi)</i>	Habitat is primarily xeric (dry) upland communities between high pine and scrub.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or high pine wooded habitats.	US FWS. 1999. Multi-Species Recovery Plan for South Florida: Sand Skink. United States Fish and Wildlife Service. http://www.fws.gov/verobeach/MSRPPDFs/SandSkink.pdf
Schaus swallowtail butterfly <i>(Heraclides aristodemus ponceanus)</i>	Occur exclusively in subtropical dry forests (hardwood hammocks) including areas that were formerly cleared and farmed, but have since regrown.	The proposed uses of dicamba DGA are not expected to overlap with forested areas or areas that were farmed but have since regrown.	US FWS. 1999. South Florida Multi-Species Recovery Plan: Schaus Swallowtail Butterfly. http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Shenandoah salamander <i>(Plethodon shenandoah)</i>	The species is found in forests, and dry, rocky, talus slopes, of mountains, generally facing north at elevations greater than 800 m in Shenandoah National park.	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 1994. Shenandoah salamander (Plethodon shenandoah Highton and Worthington) recovery plan. http://ecos.fws.gov/docs/recovery_plan/940929a.pdf

<p>Sonora tiger Salamander (<i>Ambystoma tigrinum stebbinsi</i>)</p>	<p>Found in standing water, grassland and oak woodland terrestrial habitats as well as human-constructed ponds or cattle tanks Terrestrial adults most likely spend time in mammal burrows or buried in the ground</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with aquatic, grassland or woodland habitats.</p>	<p>US FWS. 2002. Sonora tiger salamander recovery plan. http://ecos.fws.gov/docs/recovery_plan/020924.pdf.</p>
<p>Southeastern beach mouse (<i>Peromyscus polionotus niveiventris</i>)</p>	<p>Located on coastal sand dunes & coastal scrub, frontal (primary and secondary) and scrub dunes (including oak scrub), and inland habitats such as coastal strand woody plants. Habitat size is approximately 80.5 km, with young beach mice moving an average of 432 m (1,415 ft) before establishing a home range.</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with scrubland or woodland habitats</p>	<p>US FWS. 2008. Southeastern Beach Mouse (<i>Peromyscus polionotus niveiventris</i>), 5-year Review: Summary and Evaluation. Jacksonville, Florida. 36 pp. http://ecos.fws.gov/docs/five_year_review/doc1888.pdf. US FWS. 1993. Recovery Plan for the Anastasia Island and Southeastern Beach Mouse. Atlanta Georgia. 30 pp. http://ecos.fws.gov/docs/recovery_plan/930923b.pdf.</p>
<p>Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)</p>	<p>Breeding: Forested wetlands or scrub-shrub wetlands-dense riparian habitat of rivers, swamps, wetlands, lakes (USFWS 2002, p. iv). Wintering: brushy savanna edges, second growth, shrubby clearings and pastures, woodlands near water (USFWS 2002, p. iv).</p>	<p>Recommend off-field status for row crop agriculture. According to the Critical Habitat designation document (USFWS 2013) essential characteristics for southwestern will flycatcher habitat include riparian areas for flowing stream that support expansive riparian vegetation areas. Riparian trees and understory species are viewed as essential elements of flycatcher habitat. Row crop soy and corn are monocultures of non-riparian vegetation</p>	<p>USFWS 2002. Species specific recovery plan available on FWS website. http://ecos.fws.gov/docs/recovery_plans/2002/020830c.pdf USFWS. 2013. Designation of Southwestern Willow Flycatcher Critical Habitat: Final Rule. Federal Register Vol. 78 No.2.</p>

		and consequently not suitable habitat for this species.	
Spruce-fir moss spider (<i>Microhexura montivaga</i>)	Typical habitat appears to be associated with moist, well-drained moss mats growing on rocks and boulders in well-shaded situations in mature high-elevation conifer forests dominated by Fraser fir, <i>Abies fraseri</i> , often with scattered red spruce, <i>Picea rubens</i> . (US FWS 1998, p. iii)	The proposed dicamba DGA uses are not expected to overlap with high-elevation conifer forests.	US FWS, 1998, Recovery Plan. http://www.gpo.gov/fdsys/pkg/FR-2011-09-27/pdf/2011-24046.pdf
St. Andrew beach mouse (<i>Peromyscus polionotus peninsularis</i>)	Found on coastal dunes. Range of species is approximately 46 km.	The proposed uses of dicamba DGA are not expected to overlap with coastal dune habitats	US FWS. 2010. Recovery plan for St. Andrews Beach Mousse (<i>Peromyscus polionotus peninsularis</i>). United States Fish and Wildlife Service. http://ecos.fws.gov/docs/recovery_plan/20110104_SABM_recovery_plan_FINAL.pdf
Stock Island tree snail (<i>Orthalicus reses</i> (not incl. <i>nesodryas</i>))	Survive best in hardwood hammocks with smooth-barked native trees that support relatively large amounts of lichen and algae. Species is entirely arboreal except when they move to the forest floor for nesting and traveling.	The proposed uses of dicamba DGA are not expected to overlap with forested habitats	US FWS. 1999. Multi-Species Recovery Plan for South Florida: Stock Island Tree Snail. http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
California least tern (<i>Sterna antillarum browni</i>)	Coastal lagoons and estuaries (freshwater marshes, lakes, lagoons, beaches, and estuary areas. Additionally can be found in man-made habitats such as airports and land fields.	This species feeds exclusively on fish and are therefore not expected to be exposed to dicamba DGA.	US FWS. 1985. Revised California Least Tern Recover Plan. http://ecos.fws.gov/docs/recovery_plan/850927_w%20signature.pdf US FWS. 2006. California Least Tern (<i>Sterna antillarum browni</i>) 5-Year Review and Evaluation: http://ecos.fws.gov/docs/five_year_review/doc775.pdf
Florida grasshopper sparrow (<i>Ammodramus savannarum floridanus</i>)	Habitat is large (greater than 50 ha), treeless, and relatively poorly-drained grasslands that have a history of frequent fires. Average	The proposed dicamba DGA use sites are not expected to provide appropriate fire influenced habitat.	US FWS. 1999. South Florida multiple-species recovery plan.

	and maximum habitat size are 1.8 and 4.82 ha, respectively. The species requires relatively large open areas maintained by periodic fires. An analogy to row cropped areas is the effect of overgrazed grasslands with poorly structured and inappropriately dispersed habitat stands. These areas are not capable of maintaining population of the species. It is reasonable to expect that row-cropped agricultural fields provide even less suitable habitat than the already unsuitable overgrazed pasture lands.		http://ecos.fws.gov/docs/recovery_plan/140903.pdf http://www.fws.gov/verobeach/MSRPPDFs/FloridaGrasshopperSparrow.pdf
Masked bobwhite (quail) (<i>Colinus virginianus ridgwayi</i>)	Open savanna grassland within dry-tropic scrub. These birds are associated with weedy bottom lands, grassy and herb-strewn valleys, and forb-rich plains.	<ul style="list-style-type: none"> - Only known US population is in captive flock on the BANWR. Attempts to release the birds back to the wild have been unsuccessful and evidence of wild populations does not exist. "As of 2001, occurrence of wild masked bobwhite is nearly completely restricted to the captive flock occurring on the BANWR." - Habitat requirements include 15-30% scrub/shrub cover and a diverse range of grass/forb species (at least 10-12 different species). They do not use monocultures, even if it is an attractive food source. "Monocultures of even such important food species as vine mesquite grass and Johnson grass were avoided". - Once home ranges are established they do not leave their boundaries. - While this species has been seen in rangeland it has never been associated with row 	<p>US FWS. 1995. Masked Bobwhite Quail Recovery Plan.</p> <p>http://ecos.fws.gov/docs/recovery_plan/950421.pdf</p>

		crops (most likely because of the monoculture).	
Yuma clapper rail (<i>Rallus longirostris yumanensis</i>)	Salt to brackish water marshes, mangrove swamps, other tidal wetlands. Found in the lower Colorado River (LCR) and tributaries (Virgin River, Bill Williams River, lower Gila River [LGR]) in Arizona, California, Nevada; the Salton Sea in California; and the Cienegade Santa Clara and Colorado River Delta in Mexico	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1983. Yuma Clapper Rail Recovery Plan (<i>Rallus longirostris yumanensis</i>) DRAFT FIRST REVISION http://ecos.fws.gov/docs/recovery_plan/Draft%20Yuma%20Clapper%20Rail%20Recovery%20Plan,%20First%20Revision.pdf
Hualapai Mexican vole (<i>Microtus mexicanus hualpaiensis</i>)	Woodland forest types containing grasses and grass-sedge habitats. associated with moist grass-sedge areas along permanent or semi-permanent waters fed by springs or seeps in either open forest or chapparal. Good cover of grasses, sedges and forbs is characteristic of this waterside vole habitat, which is usually found in narrow bands paralleling the water	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 1991. Hualapai Mexican Vole Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910819.pdf
<u>Tern, least interior pop. (<i>Sterna antillarum</i>)</u>	Species is a piscivore, feeding in shallow waters of rivers, streams (USFWS, 1990, p. 20). Beaches, sand pits, sandbars, islands and peninsulas are the principal breeding habitats of coastal areas and nesting can be close to water but is usually between the dune environment and the high tide line. Vegetation at coastal nesting areas is sparse, scattered and short. Riverine nesting areas are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting	The proposed dicamba DGA uses are not expected to overlap with riparian areas, including coastal areas.	USFWS. 1990. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/900919a.pdf

	occurs along river banks (US FWS, 1990, p. 20).		
Mount Graham red squirrel (<i>Tamiasciurus hudsonicus grahamensis</i>)	Pinaleño Mountains in the Coronado National Forest. The species inhabits upper elevation, mature to old-growth associations in mixed conifer and spruce-fir above approximately 2,425 m (8,000 ft). The majority of surviving red squirrels now occur at lower elevations in the mixed-conifer forest that extend well down the mountain	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 2011. Draft Mount Graham Red Squirrel Recovery Plan, First Revision http://ecos.fws.gov/docs/recovery_plan/FR00000388%20Draft%20Mount%20Graham%20Red%20Squirrel%20Recovery%20Plan%20First%20Revision%20Final.pdf
Preble's meadow jumping mouse (<i>Zapus hudsonius preblei</i>)	Heavily vegetated riparian habitats. Water source (creeks, streams, rivers), consisting of shrubs, forbs, grasses, woodland, and herbaceous species and can occur upland beyond floodplain.	Habitat for the PMJM is listed as “well developed riparian vegetation, adjacent relatively undisturbed grasslands, and a nearby water source”. The mouse may travel up to 100m upland from the riparian zone but the habitat needs to be undisturbed grasslands. PCEs for the mouse include “riparian corridors... and additional adjacent floodplain and upland habitat with limited disturbance (including hayed fields, grazed pastures, other agricultural lands that are not plowed or disked regularly, etc)”	(US FWS. 1998. Endangered and Threatened Wildlife and Plants; Final Rule to List the Preble’s Meadow Jumping Mouse as a Threatened Species. http://ecos.fws.gov/docs/federal_register/fr3260.pdf US FWS. 2007. Endangered and Threatened Wildlife and Plants; Revised Proposed Rule to Amend the Listing for the Preble’s Meadow Jumping Mouse (<i>Zapus hudsonius preblei</i>) to Specify Over What Portion of Its Range the Subspecies is Threatened; Proposed Rule. http://ecos.fws.gov/docs/five_year_review/doc1719.pdf
New Mexican ridge-nosed rattlesnake (<i>Crotalus willardi obscurus</i>)	Mountains, elevated plateaus, and pine-oak vegetation	The proposed dicamba DGA uses are not expected to overlap with woodland habitats.	(US FWS. 1985. Recovery Plan for the New Mexican Ridge-Nosed Rattlesnake. http://ecos.fws.gov/docs/recovery_plan/850322.pdf
Wood stork (<i>Mycteria americana</i>)	Freshwater and estuarine Wetlands. (US FWS 1986, p. iii). Wood storks breed in FL, GA and SC. They migrate south in winter (US FWS 1986, p. 2).	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS. 1986. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/970127.pdf USFWS. 2006. Five year Review.

	<p>Require a mosaic of wetlands with varying climatological and seasonal conditions around colonies and within the wintering habitat in the coastal plain of the Southeast U.S. (US FWS 2006, p. 12).</p>		<p>http://ecos.fws.gov/docs/five_year_review/doc1115.pdf</p>
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Species	Habitat	Rationale	Source
Aquatic Organisms			
Alamosa springsnail (<i>Tryonia alamosae</i>)	The Alamosa springsnail is found mainly where minor rivulets flow out of the main channel downstream of the springhead. In these situations, there is a mat of watercress and filamentous green algae over water 1—2 inches deep flowing over fine gravel and sand among rhyolitic cobbles and rocks. The species is found in slow current on gravel and among vegetation, and is most abundant where an organic film covers the pebbles and cobbles.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1994. Socorro and Alamosa Springsnail Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940831b.pdf
Apache trout (<i>Oncorhynchus apache</i>)	Apache trout currently exist mainly in headwater areas upstream from natural and artificial barriers. This environment is subject to extreme variations in both temperature and flow.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2009. Apache Trout (<i>Oncorhynchus apache</i>) Recovery Plan, Second Revision http://ecos.fws.gov/docs/recovery_plan/090903.pdf
Arkansas River shiner (<i>Notropis girardi</i>)	Wilde et al. (2000) found no obvious selection for or avoidance of any particular habitat type (i.e., main channel, side channel, backwaters, and pools) by Arkansas River shiner. Arkansas River shiners did tend to select side channels and backwaters slightly more than expected based on the availability of these habitats (Wilde et al. 2000). Likewise, they appeared to make no obvious selection for, or avoidance of, any particular substrate type. Substrates (i.e., the river bed) in the Canadian River in New Mexico and Texas were predominantly sand, however, the Arkansas River shiner was observed to occur over silt slightly more than expected based on the availability of this substrate (Wilde et al. 2000) ;	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2005. Federal Register Notice: Designation of Critical Habitat. http://ecos.fws.gov/docs/recovery_plan/950830.pdf

	<p>preferred habitat for the Arkansas River shiner is the mainstem of larger plains rivers... historically inhabited the main channels of wide, shallow, sandy-bottomed rivers and larger streams of the Arkansas River basin (Gilbert 1980). Adults are uncommon in quiet pools or backwaters lacking streamflow, and almost never occurred in habitats having deep water and bottoms of mud or stone (Cross 1967) (US FWS 2005).</p>		
<p><u>Bean, Cumberland (pearly mussel) (Villosa trabalis)</u></p>	<p>Restricted typically to tributary streams of the upper reaches of the Tennessee and Cumberland Rivers. This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, <i>V. trabalis</i> is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species (US FWS 2010, p. 7).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 2010. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc3244.pdf</p>
<p><u>Bean, purple (Villosa perpurpurea)</u></p>	<p>Inhabits small headwater streams (Neves 1991) to medium-sized rivers (Gordon 1991). It is found in moderate to fast-flowing riffles with sand, gravel, and cobble substrates (Neves 1991) and rarely occurs in deep pools or slack water (Ahlstedt 1991a). It is sometimes found out of the main current adjacent to water-willow beds and under flat rocks (Ahlstedt 1991a,</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf</p>

	Gordon 1991) (US FWS 2004, p. 19).		
Bean, rayed (<i>Villosa fabalis</i>)	The rayed bean is generally known from smaller, headwater creeks, but occurrence records exist from larger rivers (Cummings and Mayer 1992, p. 142; Parmalee and Bogan 1998, p. 244). They are usually found in or near shoal or riffle (short, shallow length of stream where the stream flows more rapidly) areas, and in the shallow, wave-washed areas of glacial lakes, including Lake Erie (West et al. 2000, p. 253). In Lake Erie, the species is generally associated with islands in the western portion of the lake. Preferred substrates typically include gravel and sand. The rayed bean is oftentimes found among vegetation (water willow (<i>Justicia americana</i>) and water milfoil (<i>Myriophyllum</i> sp.)) in and adjacent to riffles and shoals (Watters 1988b, p. 15; West et al. 2000, p. 253) (US FWS 2012, p. 8633).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS 2012 - Federal Register Determination of Endangered Status. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf
Beautiful shiner (<i>Cyprinella formosa</i>)	Found in small to medium streams with sand, gravel, and rock bottoms below 4500 ft elevation and is also found in artificial ponds.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species fact sheet http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Beautiful%20Shiner.pdf
Birdwing pearlymussel (<i>Lemiox rimosus</i>)	The birdwing pearlymussel inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins. The species is commonly found near riffles on sand and gravel substrates with firm rubble. Individuals have been found in waters ranging from six to seven feet deep.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page http://ecos.fws.gov/docs/life_histories/F00I.html
<u>Blackside dace</u> (<u>Phoxinus</u>)	This species inhabits cool, small, upland streams with moderate flows. The fish is	The proposed dicamba DGA uses are not expected to overlap	USFWS. 1988. Recovery Plan.

cumberlandensis)	generally associated with undercut stream banks and large rocks, and it is usually found within well-vegetated watersheds with good riparian vegetation (US FWS 1988, p. 6).	with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/880817.pdf
Bonytail chub (<i>Gila elegans</i>)	This is a freshwater mainstream, big-river fish. It is also found in pools and eddies, with gravel, rocky, silt and/or silt-boulder substrates. The bonytail chub has also been found in rocky shoals and shorelines, and is adapted for swift, strong currents.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2002. Bonytail (<i>Gila elegans</i>) Recovery Goals. http://ecos.fws.gov/docs/recovery_plan/060727c.pdf
Canada lynx (<i>Lynx canadensis</i>)	PCE: Boreal forest landscapes with large populations of snowshoe hares. Distribution and abundance of prey and microclimate influence movement, hunting behavior, and den and resting site locations. Areas with dense cover.	The proposed dicamba DGA uses are not expected to overlap with boreal forests. The lynx's prey, snowshoe hares, also do not overlap with the proposed dicamba DGA use sites.	USFWS. 2014. Federal Register Notice: Designation of Critical Habitat http://www.gpo.gov/fdsys/pkg/FR-2014-09-12/pdf/2014-21013.pdf
Chihuahua chub (<i>Gila nigrescens</i>)	Deep pools, undercut banks, or over-hanging vegetation. Adults are in lateral scour pools, beneath undercut banks, under solid objects (e.g., logs, boulders) and/or adjacent to moderate to fast flowing water in small to medium sized streams. The species also utilizes corner and backwater pools containing large woody debris (also used) with extensive cover composed of organic debris or root wads of large trees. Pools are 1-2 m deep with water velocity <15 cm/sec and small grained substrates (sand to pea-sized). Juveniles are found in shallower water with or without cover in small and medium sized streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1986. Chihuahua Chub Recovery Plan http://ecos.fws.gov/docs/five_year_review/doc4325.pdf US FWS. 2007. http://ecos.fws.gov/docs/five_year_review/doc4325.pdf
Chipola slabshell (<i>Elliptio chipolaensis</i>)	The Chipola slabshell inhabits silty sand substrates of large creeks and the main channel of	The proposed dicamba DGA uses are not expected to overlap with rivers,	USFWS 2003. Recovery Plan for 7 mussels. Page 43.

	the Chipola River in slow to moderate current (Williams and Butler 1994). Specimens are generally found in sloping bank habitats. Nearly 70 percent of the specimens found during the status survey were associated with a sandy substrate (Brim Box and Williams 2000).	streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Choctaw bean (<i>Villosa choctawensis</i>)	It is found in medium creeks to medium rivers in stable substrates of silty sand to sandy clay with moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61669
Chupadera springsnail (<i>Pyrgulopsis chupaderae</i>)	Chupadera springsnail has been documented on two hillsides where groundwater discharges flow through volcanic gravels containing sand, mud, and aquatic plants with water temperatures ranging from 15 to 25 degrees Celsius (°C) (59 to 77 degrees Fahrenheit (°F)) and velocities ranging from 0.01 to 0.19 meters per second (m/s) (0.03 to 0.6 feet per second (ft/s))	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2012. Determination of Endangered Status for the Chupadera Springsnail and Designation of Critical Habitat: Final rule. http://www.gpo.gov/fdsys/pkg/FR-2012-07-12/pdf/2012-16988.pdf
Clubshell (<i>Pleurobema clava</i>)	Clubshell is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf
Colorado pikeminnow (=squawfish) (<i>Ptychocheilus lucius</i>)	The adult Colorado pikeminnow requires pools, deep runs, and eddy habitats maintained by high spring flows.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2002. Colorado Pike Minnow (<i>Ptychocheilus lucius</i>) Recovery Goals http://ecos.fws.gov/docs/recovery_plan/020828b.pdf

Combsshell, Cumberlandian (<i>Epioblasma brevidens</i>)	This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse, sand, gravel, cobble, and boulders. It is not associated with small stream habitats and tends not to extend as far upstream in tributaries (US FWS 2004, p. 18).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
Cracking pearlymussel, (<i>Hemistena lata</i>)	The cracking pearlymussel has undergone a substantial range reduction. It was historically distributed in the Ohio, Cumberland, and Tennessee River systems. The species has been extirpated throughout much of its range. It was last collected from Mussel Shoals, an 85 km reach of the Tennessee River in Alabama, prior to 1925 and is presumed to be extirpated from the shoal. It is presently known to survive at only a few shoals in the Clinch and Powell Rivers in Tennessee and Virginia, and it has likely been reduced to only three viable populations in these systems. The species possibly survives in the Green River, Kentucky, and below Pickwick Reservoir in the Tennessee River, Tennessee as well	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F01X.html
Desert pupfish (<i>Cyprinodon macularius</i>)	Habitats have included clear, shallow waters with soft substrate associated with cienegas, springs, streams, margins of larger lakes and rivers, shoreline pools, and irrigation drains and ditches below 1,585 meters (5,200 feet) in elevation. Known natural populations are now restricted to two streams tributary, and in shoreline pools and irrigation drains of, the Salton Sea in California	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2010. Desert Pupfish (<i>Cyprinodon macularius</i>) 5-Year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc3573.pdf
Diamond Darter (<i>Crystallaria cincotta</i>)	Adult diamond darters and crystal darters typically have been captured in riffle-pool transition areas with predominately (greater than	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2013. Designation of Critical Habitat for the Diamond Darter (<i>Crystallaria cincotta</i>); Final Rule

	20 percent each) sand and gravel substrates.		http://www.gpo.gov/fdsys/pkg/FR-2013-08-22/pdf/2013-20449.pdf
Dromedary pearlymussel, (<u>Dromus dromas</u>)	This species is most often observed in clean, fast-flowing water in substrates that contain relatively firm rubble, gravel and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709c.pdf
Duskytail darter, (<u>Etheostoma percnurum</u>)	This species inhabits rocky areas in gently flowing shallow pools and runs in large creeks and moderately large rivers in the Tennessee and Cumberland River Systems (US FWS, 1994, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/duskytaildarter_RP.pdf
Dwarf wedgemussel (<i>Alasmidonta heterodon</i>)	The dwarf wedge mussel lives on muddy sand, sand, and gravel bottoms in creeks and rivers of varying sizes, in areas of slow to moderate current and little silt deposition.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 1993. <u>Dwarf Wedge Mussel</u> recovery plan. Page 3.
Fanshell (<i>Cyprogenia stegaria</i>)	The fanshell inhabits gravel substrates in medium to large rivers of the Ohio River basin (US FWS, 1991, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910709.pdf
Fat three-ridge (mussel) (<i>Amblema neislerii</i>)	The fat threeridge inhabits the main channel of small to large rivers in slow to moderate current. Substrate used by this mussel varies from gravel to cobble to a mixture of sand and sandy mud (Williams and Butler 1994). Brim Box and Williams (2000) found 60 percent of the specimens were located in a sandy silt substrate.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Finback whale, (<i>Balaenoptera physalus</i>)	Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar	The proposed dicamba DGA uses are not expected to	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm

	latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally.	overlap with coastal waters.	
Finerayed pigtoed (<i>Fusconaia cuneolus</i>)	This species is typically a riffle species that inhabits ford and shoal areas in free-flowing streams of moderate gradient (US FWS, 1984, p. 7).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/fine%20rayed%20recovery%20plan.pdf
Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
Fuzzy pigtoe (<i>Pleurobema strodeanum</i>)	The fuzzy pigtoe is found in medium creeks to medium rivers in stable substrates of sand and silty sand with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshe</u> <u>ll, Round Ebonyshell,</u> <u>Southern Kidnevshell, and</u> <u>Choctaw Bean, and</u> <u>Threatened Species Status for the Tapered Pigtoe,</u> <u>Narrow Pigtoe, Southern</u> <u>Sandshell, and Fuzzy</u> <u>Pigtoe, and Designation of</u> <u>Critical Habitat: Final rule,</u> <u>Page 61673</u>
Gila chub (<i>Gila intermedia</i>)	Found in pools in smaller streams, cienegas, and artificial ponds. Highly secretive, adults prefer deeper, quieter waters in pools and eddies below riffles or runs, often remaining in cover from terrestrial vegetation, boulders, and fallen logs. Young-of-the year use the shallow margins of pools with aquatic vegetation or debris for cover. Older	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=E02P#lifeHistory

	juveniles may be found in higher velocity runs and riffles.		
Gila topminnow (incl. Yaqui) (<i>Poeciliopsis occidentalis</i>)	Shallow, warm, fairly quiet waters in ponds, cienegas, tanks, pools, springs, small streams, and the margins of larger streams. Dense mats of algae and debris along the margins of the habitats are an important component for cover and foraging. Substrates of organic muds and detritus also provide foraging areas.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E00C#lifeHistory
Gila trout (<i>Oncorhynchus gilae</i>)	clean gravel, moderate to high gradient in perennial mountain streams	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2003. Gila trout recovery plan (third revision). http://ecos.fws.gov/docs/recovery_plan/030910.pdf
Green blossom (pearly mussel) (<i>Epioblasma torulosa gubernaculum</i>)	Clean, fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas <i>E. t. gubernaculum</i> was restricted to the high gradient rivers of the Appalachian mountains and the Cumberland Plateau	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1983. Recovery Plan Green-blossom Pearly Mussel <i>Epioblasma (=Dysnomia) torulosa gubernaculum</i> . http://ecos.fws.gov/docs/recovery_plan/060228.pdf
Greenback Cutthroat trout (<i>Oncorhynchus clarki stomias</i>)	Require clear, swift -flowing mountain streams with cover such as overhanging banks and vegetation. Riffle areas are used for spawning. Juveniles tend to shelter in shallow backwaters until large enough to fend for themselves in the mainstream.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life-history page. http://ecos.fws.gov/docs/life_histories/E00F.html
Green sea turtle (<i>Chelonia mydas</i>)	Green turtles are primarily restricted to tropical and subtropical waters. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found from Massachusetts to Texas and in the U.S. Virgin Islands and Puerto Rico...Seagrasses are the principal dietary component of juvenile and adult green turtles throughout the Wider Caribbean region	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf

	(Bjorndal, 1995). (NMFS, NOAA 1998, p. 46694)		
Gulf moccasinshell (<i>Medionidus penicillatus</i>)	The Gulf moccasinshell inhabits the channels of small to medium-sized creeks to large rivers with sand and gravel or silty sand substrates in slow to moderate currents (Williams and Butler 1994; Garner, pers. comm. 2003).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Gulf sturgeon, (<i>Acipenser oxyrinchus desotoi</i>)	The Gulf sturgeon is an Anadromous fish which migrates from salt water into large coastal rivers to spawn and spend the warm months. The majority of its life is spent in fresh water (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950922.pdf
Hawksbill sea turtle, (<i>Eretmochelys imbricata</i>)	The hawksbill turtle occurs in tropical and subtropical waters of the Atlantic, Pacific, and Indian Oceans. Coral reefs, like those found in the waters surrounding Mona and Monito Islands, are widely recognized as the primary foraging habitat of juvenile, subadult, and adult hawksbill turtles. This habitat association is directly related to the species' highly specific diet of sponges (Meylan, 1988). Hawksbills depend on coral reefs for food and shelter; therefore, the condition of reefs directly affects the hawksbill's well-being. (NMFS, NOAA 1998, p. 46695)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 1998. Federal Register Notice: Designated critical habitat. http://ecos.fws.gov/docs/federal_register/fr3295.pdf
Hay's Spring amphipod (<i>Stygobromus hayi</i>)	The Hay's Spring amphipod inhabits a ground water outlet that feeds into a low gradient creek. Precise data on this habitat is lacking due to inaccessibility of habitat.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/K004.html
Humpback chub (<i>Gila cypha</i>)	Humpback chub are found in association with fast current, deep pool, and boulder habitats. They can occupy	The proposed dicamba DGA uses are not expected to overlap	US FWS. 1990. Recovery Plan for the Humpback Chub - 1990 2nd Revised Final Plan

	deep, swift riverine areas with large boulders and steep cliffs.	with aquatic environments.	http://ecos.fws.gov/docs/recovery_plan/900919c.pdf
Humpback whale (<i>Megaptera novaeangliae</i>)	<p>During migration, humpbacks stay near the surface of the ocean.</p> <p>While feeding and calving, humpbacks prefer shallow waters. During calving, humpbacks are usually found in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.</p> <p>Humpback feeding grounds are in cold, productive coastal waters.</p>	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm
James spinymussel (<i>Pleurobema collina</i>)	This species lives in stream sites that vary in width from 10-75 feet and depth of 1/2 to 3 feet. It requires a slow to moderate water current with clean sand and cobble bottom sediments. The James spinymussel is limited to areas of unpolluted water, and may be more susceptible to competition from exotic clam species when its habitat is disturbed (Clark and Neves 1984, USFWS 1990).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/life_histories/F025.html
Kemp's ridley sea turtle, (<i>Lepidochelys kempii</i>)	This life history pattern is characterized by three basic ecosystem zones: (1) Terrestrial zone (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) Neritic zone - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) Oceanic zone - the vast open	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2011. Bi-national recovery plan for the kemp's ridley sea turtle. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

	ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2011, p. I-8)		
Koster's springsnail (<i>Juturnia kosteri</i>)	They inhabit springs and spring-fed wetland systems with variable water temperatures and slow to moderate water velocities over compact substrate (material on the bottom of the stream) ranging from deep organic silts to gypsum sands and gravel. Additionally, the habitat of Koster's springsnail consists of soft substrates of springs and seeps.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2011. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf
Leatherback sea turtle, (<i>Dermochelys coriacea</i>)	Leatherbacks are able to take advantage of a wide variety of marine ecosystems (reviewed by Saba 2013; see NOAA large marine ecosystem website: http://www.lme.noaa.gov/). Within these ecosystems, various oceanic features such as water temperature, downwelling, Ekman upwelling, sea surface height, chlorophyll-a concentration, and mesoscale eddies affect the presence of leatherbacks (Bailey et al. 2013; Benson et al. 2011). The physical characteristics observed within these marine ecosystems also affect the distribution and abundance of leatherback prey (reviewed by Saba 2013). (NMFS, NOAA 2013, p. 20-22).	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS, NOAA. 2013. Five Year Review. http://ecos.fws.gov/docs/recovery_plan/090116.pdf
Lee County cave isopod (<i>Lirceus usdagalun</i>)	Found on the surfaces of small, submerged rocks and gravels in cave streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS 1997. Lee County Cave Isopod (<i>Lirceus usdagalun</i>) Recover Plan. http://ecos.fws.gov/docs/recovery_plan/970930c.pdf
Littlewing pearlymussel, (<i>Pegias fabula</i>)	This species inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1989. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/890922.pdf

	River basins (US FWS, 1989, p. 5).		
Little Colorado spinedace (<i>Lepidomeda vittata</i>)	Freshwater springs, streams and rivers. Tends to prefer pools, but occurs sporadically throughout the habitat. Predominately in open pools with undercut banks and/or boulders for cover. During periods of drought spinedace are believed to persist in springs and intermittent streambed pools; and during flooding they tend to distribute themselves throughout the stream. Found in pools with slow to moderate current adjacent to riffles; during spate conditions, in eddies lateral to the current.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1997. Little Colorado River Spinedace Recovery Plan http://ecos.fws.gov/docs/recovery_plan/980109.pdf Federal Register/Vol. 52, No. 179. September 16, 1987, Little Colorado Spinedace Critical Habitat. http://ecos.fws.gov/docs/federal_register/fr1325.pdf
Loach minnow (<i>Tiaroga cobitis</i>)	Inhabits turbulent waters over gravel and/or cobble bottoms in riffles of mainstream rivers, fast-flowing streams, and tributaries. Due to a reduced gas bladder the species is restricted almost exclusively to a bottom-dwelling habit, swimming in swift water is only for brief moments. Most habitat is relatively shallow and the fish is found at elevations up to 2200 meters.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1991. Loach Minnow Recovery Plan http://ecos.fws.gov/docs/recovery_plan/910930f.pdf
Loggerhead sea turtle, Northwest Atlantic DPS (<i>Caretta caretta</i>)	The three basic ecosystems in which loggerheads live are the: 1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur. 2. Neritic zone - the nearshore marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters. The neritic zone generally includes the continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS. NOAA. 2009. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/090116.pdf

	<p>neritic zone conventionally extends to areas where water depths are less than 200 meters.</p> <p>3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters. (NMFS, NOAA 2009, p. I-20)</p>		
<p>Madison Cave isopod (<i>Antrolana lira</i>)</p>	<p>Flooded limestone caves beneath the Great Valley of Virginia and West Virginia where it swims freely through calcite-saturated waters of deep karst aquifers</p>	<p>The proposed dicamba DGA uses are not expected to overlap with aquatic environments.</p>	<p>US FWS. Species life-history page.</p> <p>http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=K008#lifeHistory</p>
<p>Maryland darter (<i>Etheostoma sellare</i>)</p>	<p>Found in swiftly flowing streams (with rocky, rubble and gravel substrates), and prefers rock crevices and similar shelters in clean, well-oxygenated, parts of those streams.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with aquatic environments.</p>	<p>USFWS. 1985. Maryland darter revised recovery plan.</p> <p>http://ecos.fws.gov/docs/recovery_plan/851017.pdf</p>
<p>Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)</p>	<p>The Mexican long-nosed bat has evolved an apparent mutualistic association with <i>Agave sp.</i> The bat is principally a nectar feeder, foraging on the flowers of <i>Agave</i>, and in some minor proportions consuming the pollen, fruits, and any incidental insects associated with the flowers. The bats occupy mid- to high-elevational desert scrub, open conifer-oak woodlands, and pine forest habitats in the Upper Sonoran and Transition Life Zones.</p>	<p>The proposed dicamba DGA uses are not expected to overlap with the desert scrub, open conifer-oak woodlands and pine forest habitats of the bat. The bat's major resource need, <i>Agave</i> plants are not expected to be on soybean and cotton fields.</p>	<p>USFWS. 1994. Recovery Plan.</p> <p>https://ecos.fws.gov/docs/recovery_plan/940908.pdf</p>
<p>Monkeyface, Appalachian (pearly mussel) (<i>Quadrula sparsa</i>)</p>	<p>This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 7).</p>	<p>The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.</p>	<p>USFWS. 1984. Recovery Plan.</p> <p>http://ecos.fws.gov/docs/recovery_plan/840709.pdf</p>

<u>Monkeyface,</u> <u>Cumberland</u> <u>(pearlymussel)</u> <u>(Quadrula</u> <u>intermedia)</u>	This species is most often observed in clean-fast-flowing water in substrates that contain relatively firm rubble, gravel, and sand substrates swept free from siltation. These mussels are usually found buried in the substrate in shallow riffle and shoal areas (US FWS, 1984, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709b.pdf
Narrow pigtoe (<i>Fusconaia escambia</i>)	It is found in medium creeks to medium rivers, in stable substrates of sand, sand and gravel, or silty sand, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of</u> <u>Endangered Species Status</u> <u>for the Alabama Pearls shell,</u> <u>Round Ebony shell,</u> <u>Southern Kidney shell, and</u> <u>Choctaw Bean, and</u> <u>Threatened Species Status</u> <u>for the Tapered Pigtoe,</u> <u>Narrow Pigtoe, Southern</u> <u>Sandshell, and Fuzzy</u> <u>Pigtoe, and Designation of</u> <u>Critical Habitat: Final rule.</u> <u>Page 61671</u>
Noel's Amphipod (<i>Gammarus desperatus</i>)	Inhabits shallow, cool, well-oxygenated waters of streams, ponds, ditches, sloughs, and springs.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2010. Noel's amphipod (<i>Gammarus desperatus</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3600.pdf
North Atlantic Right Whale (<i>Eubalaena glacialis</i>)	The North Atlantic right whale primarily occurs in coastal or shelf waters, but may go into deeper waters. (NMFS 2004, p. v)	The proposed dicamba DGA uses are not expected to overlap with coastal waters.	NMFS. 2004. Recovery plan for the north Atlantic right whale (<i>Eubalaena glacialis</i>). Available online at: http://ecos.fws.gov/docs/recovery_plan/whale_right_northatlantic.pdf
Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)	The Ochlockonee moccasinshell inhabits large creeks and the Ochlockonee River main stem in areas with current. Typical substrates are sand with some gravel (Williams and Butler 1994).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 43. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Oval pigtoe (<i>Pleurobema pyriforme</i>)	The oval pigtoe occurs in small to medium-sized creeks to small rivers	The proposed dicamba DGA uses are not expected to	USFWS 2003. Recovery Plan for 7 mussels. Page 43.

	where it inhabits silty sand to sand and gravel substrates, usually in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Stream channels appear to offer the best habitat for this species.	overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Oyster Mussel (<i>Epioblasma capsaeformis</i>)	This species is generally adapted to live in the gravel shoals of free-flowing rivers and streams (US FWS, 2004, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2004. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/040524.pdf
Pecos assiminea snail (<i>Assiminea pecos</i>)	The Pecos assiminea requires saturated, moist soil at stream or spring-run margins and is found in wet mud or beneath mats of vegetation, usually within 1 inch (in) (2 to 3 centimeters (cm)) of flowing water. Spring complexes that contain flowing water create saturated soils that provide the specific habitat needed for population growth, sheltering, and normal behavior of the species. Although this snail seldom occurs immersed in water, the species cannot withstand permanent drying of springs or spring complexes. Consequently, wetland plant species are required to provide leaf litter (dead leaf material), shade, and appropriate microhabitat. Plant species such as <i>Scirpus americanus</i> (American three-square), <i>Eleocharis spp.</i> (spike rush), <i>Distichlis spicata</i> (inland saltgrass), and	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2011. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule. Page 33039. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf

	<i>Juncus spp.</i> (rushes) provide the appropriate cover and shelter required by Pecos assiminea (NMDGF 2005, p. 13).		
Pecos bluntnose shiner (<i>Notropis simus pecosensis</i>)	Sandy substrate with low velocity flow, and at depths between 7-16 inches. Backwater, riffles, and pools are also used by younger individuals. Natural springs which are sources of continuous water flow also serve as habitat for <i>Notropis simus pecosensis</i> .	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E04F.html
Pecos gambusia (<i>Gambusia nobilis</i>)	<i>Gambusia nobilis</i> occurs abundantly in springheads and spring runs. Moderately abundant populations are also known from areas with little spring influence, but with abundant overhead cover, sedge covered marshes, and gypsum sinkholes. <i>G. nobilis</i> has been observed to occur from the surface to depths of three meter.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS ECOS Life Histories for the Pecos gambusia (<i>Gambusia nobilis</i>) http://ecos.fws.gov/docs/life_histories/E00V.html
Pink Mucket (pearly mussel) (<i>Lampsilis abrupta</i>)	<p>The pink mucket may still exist in stretches of the lower Ohio River (US FWS, 1985, p. 10).</p> <p>The pink mucket habitat is large rivers at least 60 feet wide, where it occurs at depths up to 25 feet deep. Currents are typically moderate to fast and substrates range from silt to boulders, rubble, gravel, and sand (US FWS, 1985, p. 11). The species seems to have adapted to living in impounded waters, at least in the upper reaches where the water is flowing (US FWS, 1985, p. 10).</p>	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1985. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/pink%20mucket%20rp.pdf
Purple bankclimber (mussel)	The purple bankclimber inhabits small to large river channels in slow to	The proposed dicamba DGA uses are not expected to	USFWS 2003. Recovery Plan for 7 mussels. Page 43.

<i>(Elliptoides sloatianus)</i>	moderate current over sand or sand mixed with mud or gravel substrates (Williams and Butler 1994).	overlap with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)	Primarily an inhabitant of small to medium sized streams and some larger rivers. It usually occurs in shallow water areas along the bank and adjacent runs and shoals with reduced water velocity. They have been reported in deep water runs up to 12 feet depth. "Bottom substrates generally include gravel and sand" (US FWS, 2012, p. 63446).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice. http://www.gpo.gov/fdsys/pkg/FR-2012-10-16/pdf/2012-24151.pdf
Razorback sucker (<i>Xyrauchen texanus</i>)	Fresh, large warm-water rivers: deep runs, eddies, backwaters, flooded off-channel. The species prefers shallow swift waters of mid-channel sandbars (less than 12ft deep) during the summer months, and slow runs, slack waters and eddies (2.0 to 4.6ft) in the winter.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2002. Razorback Sucker (<i>Xyrauchen texanus</i>) Recovery Goals. http://ecos.fws.gov/docs/recovery_plan/060727c.pdf
Riffleshell, northern (<i>Epioblasma torulosa rangiana</i>)	The habitat of the riffleshell occurs in packed sand and gravel in riffles and runs, and also in the western basin of Lake Erie where there is sufficient wave action to produce continuously moving water (US FWS, 1994, p. 18). FWS further describes the habitat as medium to large rivers where they are often associated with high water velocities, although they have also been documented in Lake Erie and in deep more slow-flowing rivers down to 20 feet (US FWS, 2009, p. 9).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1994. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/940921.pdf USFWS. 2009. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc3284.pdf
Rio Grande silvery minnow (<i>Hybognathus amarus</i>)	In general, the species is most often found in areas of low or moderate water velocity (e.g., eddies formed by debris piles, pools, backwaters, and embayments), and is rarely found in habitats with high	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1999. Rio Grande Silvery Minnow Recovery Plan (<i>Hybognathus amarus</i>) First Revision http://ecos.fws.gov/docs/recovery_plan/022210_v2.pdf

	water velocities, such as main channel runs, which are often deep and swift.		
Roanoke logperch (<i>Percina rex</i>)	The Roanoke logperch occupies medium to large warm-water streams and rivers of moderate gradient with relatively unsilted substrata. During different phases of life history and season, every major riverine habitat is exploited by the logperch. Except in winter, all age classes are intolerant of moderately to heavily silted substrata. It is found in two river systems in Virginia-The Roanoke River drainage.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E01G.html
Round Ebonyshell (<i>Fusconaia rotulata</i>)	It occurs in small to medium rivers, typically in stable substrates of sand, small gravel, or sandy mud in slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61668
Rough pigtoe, (<i>Pleurobema plenum</i>)	The rough pigtoe habitat is medium to large rivers, 60 feet or wider, in sand and gravel substrates. Very limited collection information suggests it occurs below spillways, in transition zones, and in sand and gravel substrates (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840806.pdf
Roswell springsnail (<i>Pyrgulopsis roswellensis</i>)	Springs and spring-fed wetland systems with slow to moderate flowing water velocities, deep organic silts to limestone cobble and gypsum substrates and stable water levels.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2012. Designation of Critical Habitat for Roswell Springsnail, Koster's Springsnail, Noel's Amphipod, and Pecos Assiminea; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2011-06-07/pdf/2011-13227.pdf

Rough rabbitsfoot (<i>Quadrula cylindrica strigillata</i>)	Found in medium to large rivers with silt, sand gravel or cobble substrates, in eddies at edge of midstream currents. The species may be associated with macrophyte beds.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2004. Recovery Plan for Rough Rabbitsfoot (<i>Quadrula cylindrica strigillata</i>) http://ecos.fws.gov/docs/recovery_plan/040524.pdf
San Bernardino springsnail (<i>Pyrgulopsis bernardina</i>)	Associated with seeps, spring runs, and especially perennial spring systems that produce running water	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2012. Determination of Endangered Status for Three Forks Springsnail and Threatened Status for San Bernardino Springsnail Throughout Their Ranges and Designation of Critical Habitat for Both Species; Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-04-17/pdf/2012-8811.pdf
Shiny entire pigtoe, (<i>Fusconaia cor</i>)	This species is typically a riffle species, found along fords and shoals of clear, moderate to fast-flowing streams and rivers with stable substrate. It does not inhabit deep pools or impounded areas. This species is usually found well-buried in the substrate during most of the year and is more readily visible in early summer (US FWS, 1984, p. 8).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1984. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840709d.pdf
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)	Shortnose sturgeon are found in rivers, estuaries, and the sea, but populations are confined mostly to natal rivers and estuaries. The species appears to be estuarine anadromous in the southern part of its range, but in some northern rivers it is	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS 1998. Final Recovery Plan for the Shortnose Sturgeon (<i>Acipenser brevirostrum</i>). Page 25. Available at: http://ecos.fws.gov/docs/recovery_plan/sturgeon_shortnose_1.pdf

	"freshwater amphidromous", i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life (Kieffer and Kynard 1993). Adults in southern rivers forage at the interface of fresh tidal water and saline estuaries and enter the upper reaches of rivers to spawn in early spring (Savannah River: Hall et al. 1991; Altamaha River: Heidt and Gilbert 1979; Flouronoy et al. 1992, Rogers and Weber 1995a; Ogeechee River: Weber 1996).		
Slabside pearlymussel, (<i>Pleuroaia dolabelloides</i>)	Associated with the Cumberland and Tennessee River drainages. Generally live embedded in the bottom of stable streams and other bodies of water, and within riffle areas of sufficient current velocities to remove finer sediments and provide well oxygenated waters (US FWS, 2013, p. 59560)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2013. Federal Register Notice: Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2013-09-26/pdf/2013-23357.pdf
<u>Slender chub</u> (<i>Erimystax cahni</i>)	The slender chub is restricted to the upper Tennessee River drainage in Tennessee and Virginia (US FWS 2014, p. 6)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. 5 Year Review. http://ecos.fws.gov/docs/five_year_review/doc4357.pdf
Shiner, smalleye (<i>Notropis buccula</i>)	Occur in fairly shallow, flowing water, often less than 0.5 m deep with sandy substrates (US FWS 2014, p. 45252)	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2014. Designation of Critical Habitat. http://www.gpo.gov/fdsys/pkg/FR-2014-08-04/pdf/2014-17694.pdf
Smalltooth sawfish (<i>Pristis pectinata</i>)	Smalltooth sawfish are tropical marine and estuarine fish that have the northwestern terminus of their Atlantic range in the waters of the eastern United States. In the United States, smalltooth sawfish are generally a shallow water	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	NMFS, NOAA. 2001. Federal Register Notice: Proposed Endangered Status for a DPS of Smalltooth Sawfish. http://ecos.fws.gov/docs/federal_register/fr3741.pdf

	fish of inshore bars, mangrove edges, and seagrass beds, but are occasionally found in deeper coastal waters. (US FWS NMFS, NOAA 2001, p. 19416)		
Sheepnose mussel, (<i>Plethobasus cyphus</i>)	The sheepnose is a larger-stream species occurring primarily in shallow shoal habitats with moderate to swift currents over coarse sand and gravel. Habitats with sheepnose may also have mud, cobble, and boulders. Sheepnose in larger rivers may occur at depths exceeding 6 m (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)	The shinyrayed pocketbook inhabits small to medium-sized creeks, to rivers in clean or silty sand substrates in slow to moderate current (Williams and Butler 1994; Garner, pers. comm. 2003). Specimens are often found in the interface of stream channel and sloping bank habitats, where sediment particle size and current strength are transitional. Clench and Turner (1956) noted it preferred small creeks and spring-fed rivers.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2003. Recovery Plan for 7 mussels. Page 42. http://ecos.fws.gov/docs/recovery_plan/030930.pdf
Snuffbox Mussel (<i>Epioblasma triquetra</i>)	The habitat is described as swift currents and riffles, and shoals and wave-washed shores of lakes over gravel and sand with occasional cobble and boulders. They generally burrow deep into the substrate (US FWS, 2010, p 67554). This constitutes a wide diversity of habitats. However, they do not occur in impounded areas or reservoirs (except tailwaters) (US FWS, 2012, p 8652).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2010. Federal Register Notice: Listing. http://www.gpo.gov/fdsys/pkg/FR-2010-11-02/pdf/2010-27413.pdf#page=2 USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-02-14/pdf/2012-2940.pdf

<u>Spectaclecase (mussel)</u> <u>(Cumberlandia monodonta)</u>	The spectaclecase generally inhabits large rivers where it occurs in microhabitats sheltered from the main force of current. It occurs in a variety of substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. It is most often found in firm mud between large rocks in quiet water very near the interface with swift currents (US FWS, 2012, p 14916).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Federal Register Notice: Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2012-03-13/pdf/2012-5603.pdf
<u>Spotfin chub (Erimonax monachus)</u>	The species is an insectivore, feeding diurnally presumably by both sight and taste in benthic areas of slow to swift current over various substrates with little siltation. Streams may range from 15-60 m in width and, where occupied, 0.3-10.0 m in depth. Water temperature in their summer habitat usually reaches greater than 20°C, and submerged macrophytes are usually absent, occasionally common. The species has been observed associated with sand, gravel, rubble, boulder, and bedrock substrates (Jenkins and Burkhead, 1982) (US FWS 1983, p. 15).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/831121.pdf
Socorro isopod <i>(Thermosphaeroma thermophilus)</i>	Small pools and runs characterized by relatively stable temperatures and physical factors with algae covering most surfaces.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1982. Socorro Isopod Recover Plan. http://ecos.fws.gov/docs/recovery_plan/820216.pdf
Socorro springsnail <i>(Pyrgulopsis neomexicana)</i>	Occurs on stones and among aquatic plants. <i>Pyrgulopsis neomexicana</i> is also found in the uppermost layer of an organic muck substrate with slow moving currents in rivers and streams.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1991. Final Rule To List the Alamosa Springsnail and the Socorro Springsnail as Endangered http://ecos.fws.gov/docs/federal_register/fr1933.pdf
Sonora chub <i>(Gila ditaenia)</i>	Perennial and spatially intermittent small to moderately sized streams. It prefers pools near cliffs, boulders, or other cover in stream channels. The chub is restricted to one river system.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1992. Sonora Chub Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/920930.pdf

	and as noted, is able to move through the system when flows are suitable.		US FWS. Species Fact Sheet for SONORA CHUB (<i>Giladitaenia</i>) http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Sonora%20Chub%20RB.pdf
Southern kidneyshell (<i>Ptychobranhus jonesi</i>)	It is typically found in medium creeks to small rivers in firm sand substrates with slow to moderate current (Williams et al. 2008, pp. 625).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule. Page 61668</u>
Southern sandshell (<i>Hamiota (=Lampsilis) australis</i>)	The southern sandshell is typically found in small creeks and rivers in stable substrates of sand or mixtures of sand and fine gravel, with slow to moderate current.	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule. Page 61672</u>
Spikedace (<i>Meda fulgida</i>)	Moderate to large perennial streams with moderate to swift currents. It inhabits shallow riffles with sand gravel and rubble substrates. Specific habitat consists of shear zones where rapid flow borders slower flow, areas of sheet flow at the upper end of mid-channel sand/gravel bars and eddies at downstream riffle edges. All suitable habitats are found under 2,000 meters elevation.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E05J.html
Tan riffleshell (<i>Epioblasma florentina</i>)	This species inhabits streams described as shallow and turbid with numerous riffles	The proposed dicamba DGA uses are not expected to overlap	USFWS. 1984. Recovery Plan.

<i>walkeri</i> (=E. <i>walkeri</i>)	and substrate consisting of loose rocks and gravel bars with an abundance of water willow (US FWS, 1984. P, 7).	with rivers, streams, creeks, or other water bodies.	http://ecos.fws.gov/docs/recovery_plan/tan%20riffleshell%20rp.pdf
Tapered pigtoe (<i>Fusconaia burkei</i>)	The tapered pigtoe is found in medium creeks to medium rivers in stable substrates of sand, small gravel, or sandy mud, with slow to moderate current (Williams et al. 2008, p. 296).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS 2012. <u>Determination of Endangered Species Status for the Alabama Pearlsnail, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat: Final rule.</u> Page 61670
Three Forks Springsnail (<i>Pyrgulopsis trivialis</i>)	Shallow waters up to 6 cm (2.35 in) deep, high conductivity, alkaline waters of pH 8, and suitable substrates that are typically firm, characterized by cobble, gravel, sand (and sometimes fine-grained mud), woody debris, and aquatic vegetation such as watercress.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2011. ; Proposed Endangered Status for the Three Forks Springsnail and San Bernardino Springsnail, and Proposed Designation of Critical Habitat; Proposed Rule http://www.gpo.gov/fdsys/pkg/FR-2011-04-12/pdf/2011-8176.pdf
Tubercled blossom (pearly mussel) (<i>Epioblasma torulosa torulosa</i>)	Large-river species that was endemic to the Ohio River system.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2011 Tubercled Blossom <i>Epioblasma torulosa torulosa</i> 5-Year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc3781.%20torulosa.pdf
Virgin River Chub (<i>Gila seminuda</i> (=robusta))	Virgin River chubs are most often associated with deep runs or pool habitats of slow to moderate velocities with large boulders or instream cover, such as root snags. Adults and juveniles are often associated together within these habitats; however, the larger adults are collected most often in the deeper pool habitats within the river.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2013. Virgin River Fishes Recover Plan http://ecos.fws.gov/docs/recovery_plan/950419a.pdf

West Indian Manatee (<i>Trichechus manatus latirostris</i>)	This species lives in freshwater, brackish and marine habitats (US FWS, 2001, Executive Summary).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	US FWS. 2001. Recovery Plan- Third Revision. http://ecos.fws.gov/docs/recovery_plan/011030.pdf
Woundfin (<i>Plagopterus argentissimus</i>)	Rivers and creeks, depths between 0.15 and 0.42 m and velocities between 0.24 and 0.49 m/s and sandy substrates.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page. http://ecos.fws.gov/docs/life_histories/E00Z.html
Yaqui catfish (<i>Ictalurus pricei</i>)	Larger rivers in areas of medium to slow	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1994. Yaqui Fishes Recovery Plan http://ecos.fws.gov/docs/recovery_plan/950329.pdf
Yaqui chub (<i>Gila purpurea</i>)	Inhabits deeper pools of small streams near undercut banks and debris between 1,219 - 1,828 m (4,000 - 6,000 ft). Is also found in pools associated with springheads. Also occurs in artificial ponds.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species Fact Sheet. http://www.fws.gov/southwest/cs/arizona/Documents/Redbook/Yaqui%20Chub%20RB.pdf
Madtom, yellowfin (<i>Noturus flavipinnis</i>)	This species prefers pool habitats beneath cobble and small boulder substrates (Miller 2011). The strongest habitat models identified preferred pools for yellowfin madtoms as greater than 40 meters in length with gravel being the main substrate beneath cover rocks (Miller 2011). (US FWS, 2012, p. 16).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 2012. Five Year Review. http://ecos.fws.gov/docs/five_year_review/doc4146.pdf
Zuni Bluehead Sucker (<i>Catostomus discobolus yarrowi</i>)	Stream reaches with clean, perennial water flowing over hard substrate (material on the stream bottom), such as bedrock. Habitat areas are generally shaded with water velocities of less than 0.1 meter per second (0.3 feet per second) in water that was 30 to 50 cm (12 to 20 in) deep with cobble, boulders, and bedrock substrate. Pools often edged by emergent aquatic plants and riparian vegetation.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2014. Endangered Species Status for the Zuni Bluehead Sucker; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2014-07-24/pdf/2014-17205.pdf
American crocodile (<i>Crocodylus acutus</i>)	Found primarily in mangrove swamps and along low-energy mangrove-lined bays, creeks, and inland swamps. During the non-nesting	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.)

	season, they are found primarily in the fresh and brackish-water inland swamps, creeks, and bays, retreating further into the back country in fall and winter. Can be found in inland ponds and creeks, protected coves exposed shorelines mud flats.		http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Atlantic salt marsh snake <i>(Nerodia clarkii taeniata)</i>	The Atlantic salt marsh snake inhabits coastal salt marshes and mangrove swamps. Specifically, it occurs along shallow tidal creeks and pools, in a saline environment ranging from brackish to full strength. It is often associated with fiddler crab burrows.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Profile page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=C01T#lifeHistory
Elkhorn coral <i>(Acropora palmata)</i>	Turbulent shallow water on the seaward face of reefs in water ranging from 1 to 5 m in depth. It has been found in waters up to 30 m in depth.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2008. Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2008-11-26/pdf/E8-27748.pdf#page=1
Okaloosa darter <i>(Etheostoma okaloosae)</i>	Fast-flowing streams. Bottoms are mostly sand, with detritus collecting in areas along the edges and eddy areas where the currents are deflected. Darter streams are heavily shade over most of their courses with ti-ti, alder, wax myrtle, oak, pine, juniper, and black gum.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. Species life history page http://ecos.fws.gov/docs/life_histories/E00H.html
Squirrel Chimney Cave shrimp <i>(Palaemonetes cumingii)</i>	Squirrel Chimney cave system. Entrance is a steep to vertical sloped sink with a shaft 3-6 ft wide and extends to the main cave and is referred to as a chimney. The cave has bedding plane tunnels, ledges, and a debris cone which opens to an air chamber.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2008. Squirrel Chimney Cave shrimp (<i>Palaemonetes cumingii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1919.pdf
Staghorn coral <i>(Acropora cervicornis)</i>	Staghorn coral commonly grows in more protected, deeper water ranging from 5 to 20 m in depth and has been found in rare instances to 60 m.	The proposed dicamba DGA uses are not expected to overlap with aquatic environments.	US FWS. 2008. Critical Habitat for Threatened Elkhorn and Staghorn Corals; Final Rule http://www.gpo.gov/fdsys/pkg/FR-2008-11-26/pdf/E8-27748.pdf#page=1

Species	Habitat	Rationale	Source
Plants			
Acuna Cactus <i>(Echinomastus erectocentrus var. acunensis)</i>	The acuña cactus occurs in valleys and on small knolls and gravel ridges of up to 30 percent slope in the Palo-Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran desertscrub at 365 to 1,150 m (1,198 to 3,773 ft) in elevation. The plant is not found on all seemingly suitable habitat and microclimate (soil structure, chemistry, and moisture) may be important factors.	The proposed dicamba DGA uses are not expected to overlap with desert environments.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=Q00U#lifeHistory
American chaffseed, <i>(Schwalbea americana)</i>	Habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with pine flatwoods, fire-maintained savannas, wetland or sedge dominated systems.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950929c.pdf
American hart's tongue fern, <i>(Asplenium scolopendrium var. americanum)</i>	Early successional habitats Northern populations occur in forests of secondary growth where canopy openings are abundant. New York populations occur in conifer forests. Bryophyte beds are an important substrate.	The proposed dicamba DGA uses are not expected to overlap early successional forests, conifer forests or bryophyte beds where the species is found.	http://ecos.fws.gov/docs/recovery_plan/930915.pdf
Arizona Cliff-rose <i>(Purshia (=Cowania) subintegra)</i>	Dry. At each site <i>P. subintegra</i> is part of a locally unique vegetative community. The geographic and local distribution of <i>P. subintegra</i> appears to be limited by competition from other plant species rather than a requirement for a specific soil type. Distribution may be limited by competition from creosotebush.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2013. Arizona Cliffrose (<i>Purshia subintegra</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc4260.pdf
Arizona hedgehog cactus	Plants are found on dacite or granite bedrock, open slopes, in narrow cracks between	The proposed uses of dicamba DGA are not	US FWS. 2008. 5-Year Reviews of 28 Southwestern Species

<i>(Echinocereus triglochidiatus var. arizonicus)</i>	boulders, and in the understory of shrubs in the ecotone between Madrean Evergreen Woodland and Interior Chaparral.	expected to overlap with desert habitats.	http://www.gpo.gov/fdsys/pkg/FR-2008-03-20/pdf/E8-5632.pdf#page=1
Brady pincushion cactus <i>(Pediocactus bradyi)</i>	<i>Pediocactus bradyi</i> is restricted to habitat composed of Kaibab limestone chips overlying soil derived from Moenkopi shale and sandstone outcrops. Chert and quartzite pebbles eroded from the Shinarump member of the Chinle Formation are also present at some sites (USFWS 1985). The rock chips that overlay the soil have clear crystalline coatings and a whiter color that appears distinct from the adjacent brown limestones where few or no <i>P. bradyi</i> occur	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2012. Brady Pincushion Cactus (<i>Pediocactus bradyi</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc4036.pdf
Canby's dropwort <i>(Oxypolis canbyi)</i>	Coastal plains - specifically in pond cypress savannas, the shallows and edges of cypress pond/pine sloughs, and wet pine savannas. These are shallowly flooded, open habitats. Found in natural ponds dominated by cypress, grass-sedge dominated Carolina bays. (USFWS 1990) Wetlands (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1990 USFWS Canby's dropwort recovery plan 2010 USFWS Canby's dropwort 5-year review
Canelo Hills ladies'-tresses <i>(Spiranthes delitescens)</i>	Occurs in rare wetland habitats in southern Arizona and northern Sonora, Mexico called "ciénegas." Ciénegas are mid-level wetland communities, often surrounded by relatively arid environments, that are usually associated with perennial springs or stream headwaters. They have permanently or seasonally saturated organic soils, and have a low probability of flooding or scouring.	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1997. ETWP; Determination of Endangered Status for Three Wetland Species Found in Southern Arizona and Northern Sonora, Mexico (62 FR 665 689) http://ecos.fws.gov/docs/federal_register/fr3030.pdf
Carter's small-flowered flax	Proposed PCE's for this species are areas of pine	The proposed uses of dicamba DGA are not	US FWS. 2013. Designation of Critical Habitat for

<i>(Linum carteri carteri)</i>	rockland habitat with frequent disturbances (e.g. fire)	expected to overlap with pine rockland habitats with frequent disturbance regimes.	Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax). http://www.gpo.gov/fdsys/pkg/FR-2013-10-03/pdf/2013-24174.pdf
Clay-loving wild buckwheat <i>(Eriogonum pelinophilum)</i>	Distribution is linked to soil type. Found within swales and drainages. Mat saltbrush community.	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 2009. Clay-loving wild buckwheat 5-year review http://ecos.fws.gov/docs/five_year_review/doc2635.pdf
Cochise pincushion cactus <i>(Coryphantha robbinsorum)</i>	Bedrock and stony soils of the Permian Limestone Formation. Transition zone between the Chihuahuan desert scrub and the semi-desert grassland habitats. Occupies limestone hills. Grows on bedrock areas with very little soil in sunny, open, well-drained areas	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1993. Cochise pincushion cactus (Coryphantha robbinsorum) recovery plan. http://ecos.fws.gov/docs/recovery_plan/930927c.pdf
Butterfly plant, Colorado (<i>Gaura neomexicana</i> var. <i>coloradensis</i>)	This species requires early- to mid-succession riparian habitat. It commonly occurs in habitat types that are usually intermediate in moisture between wet, streamside communities dominated by sedges, rushes, and cattails, and dry, upland short-grass prairie. Typically, Colorado butterfly plant habitat is open, without dense or overgrown vegetation (US FWS, 2010).	The proposed dicamba DGA uses are not expected to overlap with riparian habitat or upland prairies.	USFWS. 2010. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/Colorado%20Butterfly%20Plant%20Recovery%20Outline_Final_May%202010.pdf
Colorado hookless Cactus <i>(Sclerocactus glaucus)</i>	Populations of <i>S. glaucus</i> occur on alluvial benches and lower mesa slopes along the Green, Colorado, and Gunnison Rivers. Soils are usually coarse, gravelly river alluvium above the river flood plains. Mancos shale with volcanic cobbles and pebbles form surface material	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 2010. Recovery Outline for the Colorado hookless cactus (<i>Sclerocactus glaucus</i>) http://ecos.fws.gov/docs/recovery_plan/CO%20hookless%20cactus_recovery%20outline_Apr%202010.pdf
Cooley's meadowrue	Grassland/herbaceous, woody wetland, and	The proposed dicamba DGA uses are not expected to	1994 USFWS Recovery Plan

<i>(Thalictrum cooleyi)</i>	herbaceous wetlands (p. i). (USFWS 1994)	overlap with wetlands.	http://ecos.fws.gov/docs/recovery_plan/940421.pdf
DeBeque phacelia <i>(Phacelia submutica)</i>	DeBeque phacelia is restricted to exposures of chocolate to purplish brown and dark charcoal gray alkaline clay soils derived from the Atwell Gulch and Shire members of the Wasatch Formation. These expansive clay soils are found on moderately steep slopes, benches, and ridge tops adjacent to valley floors of the southern Piceance Basin in Mesa and Garfield Counties, Colorado. On these slopes and soils, DeBeque phacelia usually grows only on one unique small spot of ground that shows a slightly different texture, color, and crack pattern than the similar surrounding soils. We do not have a precise scientific description of the soil features required to support this species. The natural shrink-swell cracking process creates the conditions needed for the plants and seed bank to thrive. Its habitat lies at the interface of the North-Central Highlands and Rocky Mountain Section and the Intermountain Semi-desert and Desert Province.	The proposed uses of dicamba DGA are not expected to overlap with steep slopes, benches or ridge tops.	US FWS. 2013. Recovery Outline DeBeque phacelia (<i>Phacelia submutica</i>) http://ecos.fws.gov/docs/recovery_plan/Debeque%20Phacelia%20Recovery%20Outline.pdf
Dudley Bluffs bladderpod <i>(Lesquerella congesta)</i>	Found on drainages along barren outcrops formed by erosion by the downcutting of streams in the Piceance Basin. Grows on level surfaces at the points of ridges and on narrow outcrops of exposed, level, white shale. Surrounding hills and mesas are juniper and pinyon woodlands	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Dudley's bluff bladderpod (<i>Lesquerella congesta</i>) and Dudley's bluff twinpod (<i>Physaria obcordata</i>) recovery plan http://ecos.fws.gov/docs/recovery_plan/930813a.pdf
Dudley Bluffs twinpod <i>(Physaria obcordata)</i>	Found on drainages along barren outcrops formed by erosion by the downcutting of streams in the Piceance Basin. Grows on steep sideslopes. Surrounding hills	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Dudley's bluff bladderpod (<i>Lesquerella congesta</i>) and Dudley's bluff twinpod (<i>Physaria obcordata</i>) recovery plan

	and mesas are juniper and pinyon woodlands.		http://ecos.fws.gov/docs/recovery_plan/930813a.pdf
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)	The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges and even fens and sphagnum bogs. It requires full sunlight for optimum growth and flowering, which restricts it to grass- and sedge-dominated plant communities. The substrate of the sites where it occurs ranges from more or less neutral to mildly calcareous, typically glacial soils. It is often early successional, but can be maintained in mid- to late successional wetlands that remain open and sunny (US FWS, 1999, pp. 6-7).	The proposed dicamba DGA uses are not expected to overlap with grass or sedge-dominated plant communities.	USFWS. 1999. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990929.pdf
Fickeisen Plains cactus (<i>Pediocactus peeblesianus fickeiseniae</i>)	Occurs on shallow soils derived from exposed layers of Kaibab limestone. Most populations occur on the margins of canyon rims, on flat terraces or benches, or on the toe of well-drained hills with less than 20 percent slope. Within the Plains and Great Basin grasslands and the Great Basin desert scrub vegetation communities.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q1C9#lifeHistory
Florida brickell-bush (<i>Brickellia mosieri</i>)	Proposed PCE's for this species are areas of pine rockland habitat with frequent disturbances (e.g. fire)	The proposed uses of dicamba DGA are not expected to overlap with pine rockland habitats with frequent disturbance regimes.	US FWS. 2013. Designation of Critical Habitat for <i>Brickellia mosieri</i> (Florida Brickell-bush) and <i>Linum carteri</i> var. <i>carteri</i> (Carter's Small-flowered Flax). http://www.gpo.gov/fdsys/pkg/FR-2013-10-03/pdf/2013-24174.pdf

Fringed campion (<i>Silene polypetala</i>)	Occurs in hardwood forests in bottomland and ravines. It is often on fairly steep slopes of deep ravines or north-facing hillsides, sometimes on nearly level ground, particularly in flatwoods developed on Iredell soils. Occurs mainly in small isolated patches of rich hardwood. The great majority of populations occur in the watershed of the Apalachicola River and its tributary, the Flint River. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with forests.	1996 USFWS Technical Agency Draft Recovery Plan for Fringed Campion (<i>Salene polypetula</i>) USFWS Species Profile: Fringed campion (<i>Silene polypetala</i>) (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?sPCODE=Q21P)
Gentian pinkroot (<i>Spigelia gentianoides</i>)	Well drained upland pinelands; longleaf pine-wiregrass ecosystem (USFWS 2012)	The proposed dicamba DGA uses are not expected to overlap with forests.	2012 US FWS Gentian pinkroot 5-Year Review
Gierisch mallow (<i>Sphaeralcea gierischii</i>)	Found on gypsum outcrops associated with the Harrisburg Member of the Kaibab Formation in northern Mohave County, Arizona and closely adjacent Washington County, Utah. The surrounding plant community is that of warm desertscrub (Mohave desertscrub)	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. Species profile page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?sPCODE=Q3LJ
Gypsum wild-buckwheat (<i>Eriogonum gypsophilum</i>)	Chihuahuan region of the Desert Scrub Formation. The climate is semi-arid and receives an average of about 14 inches of precipitation per year	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1981. 50 CFR Part 17. Endangered and Threatened Plants; Determination of two New Mexico Plants to be Endangered Species and Threatened Species with Critical Habitat. Final Rule. Federal Register / Vol. 46, No. 12 / Monday, January 19, 1981 / Rules and Regulations. http://ecos.fws.gov/docs/federal_register/fr515.pdf
<u>Harperella</u> (<u><i>Ptilimnium nodosum</i></u>)	Harperella is known from only two locations in North Carolina. One population occurs in the Tar River in Granville County. Another population was reintroduced to the Deep	The proposed dicamba DGA uses are not expected to overlap with river habitats.	USFWS. 1991. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/910305b.pdf

	River recently after the original population known from that area disappeared. This population occurs in Chatham County, but the river serves as the divide between Chatham and Lee counties (US FWS, 1991).		
Holmgren milk-vetch (<i>Astragalus holmgreniorum</i>)	Grows on the shallow, sparsely vegetated soils derived primarily from the Virgin limestone member of the Moenkopi Formation. The species is a principal member of a warm-desert shrub vegetative community.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2006. <i>Astragalus holmgreniorum</i> (Holmgren Milk-Vetch) and <i>Astragalus ampullarioides</i> (Shivwits Milk-Vetch): Recovery Plan http://ecos.fws.gov/docs/recovery_plan/060929.pdf
Holy Ghost ipomopsis (<i>Ipomopsis sancti-spiritus</i>)	Holy Ghost ipomopsis is known from a single population in the Sangre de Cristo Mountains of San Miguel County in north-central New Mexico (Figure 2). Plants are relatively continuous in scattered patches for about 3.5 kilometers (km) (2.2 miles (mi)) of Holy Ghost Canyon beginning 1.6 km (1.0 mi) above the confluence with the Pecos River then up Holy Ghost Creek to the confluence with Doctor Creek. There are about 80 hectares (ha) (200 acres (ac)) of occupied habitat. The Santa Fe National Forest manages most of the habitat. The USFS maintains a campground and leases land in Holy Ghost Canyon as the Holy Ghost Summer Home Area. About 80 percent of the population grows on, or immediately adjacent to, the west-facing cutslopes along Forest Road 122 in Holy Ghost Canyon. Plant density varies from small dense patches (5 plants/m2)	The proposed uses of dicamba DGA are not expected to overlap with montane forest habitats.	US FWS. 2002. Holy Ghost Ipomopsis (<i>Ipomopsis sancti-spiritus</i>) Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/020926.pdf

	<p>to single, isolated plants found greater than 50 m from others. The occupied habitat in Holy Ghost Canyon ranges in elevation from 2,350 - 2,500 m (7,730 - 8,220 ft). Holy Ghost ipomopsis occurs in the Rocky Mountain montane conifer forest plant community (Brown 1982). Commonly associated species are ponderosa pine (<i>Pinus ponderosa</i>), Douglas fir (<i>Pseudotsuga menziesii</i>), aspen (<i>Populus tremuloides</i>), Gambel oak (<i>Quercus gambelii</i>), mountain mahogany</p>		
Houghton's goldenrod (<i>Solidago houghtonii</i>)	This plant grows on the shores of the Great Lakes, mainly Lake Huron and Lake Michigan, at the Michigan-Ontario border. (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with shores.	2011 US FWS Houghton's Goldenrod (<i>Solidago houghtonii</i> A. Gray, Asteraceae) 5-Year Review: Summary and Evaluation
Huachuca water-umbel (<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>)	Cienegas (marshy wetlands) and associated vegetation within Sonoran desert scrub, grassland or oak woodland, and conifer forest	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1997. <i>Lilaeopsis schaffneriana</i> ssp. <i>recurva</i> . http://ecos.fws.gov/docs/five_year_review/doc4435.pdf
Jones Cycladenia (<i>Cycladenia humilis</i> var. <i>jonesii</i>)	The species can be found in Eriogonum-Ephedra, mixed desert shrub, and scattered pinyon-juniper communities, at elevations ranging from 4,390 to 6,000 feet elevation in plant communities.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2008. Recover outline for the Jones Cycladenia (<i>Cycladenia humilis</i> var. <i>jonesii</i>) http://ecos.fws.gov/docs/recovery_plan/Jones%20cycladenia_123008.pdf
Kearney's blue-star (<i>Amsonia kearneyana</i>)	South Canyon in the Baboquivari Mountains, Brown Canyon, Jaguar Canyon, and Thomas Canyon. In two distinct habitats: open woodland on unconsolidated slopes of over 20 degrees, and canyon bottoms in full sun to partial shade. once thought to only occupy canyon bottoms, we now know that this is secondary habitat for the species, with most subpopulations being located	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 2013. 5-Year-Review for Kearney Bluestar – 2013 http://ecos.fws.gov/docs/five_year_review/doc4261.pdf

	on steep, dry, and open woodland-dominated slopes		
Knowlton's cactus <i>(Pediocactus knowltonii)</i>	The species occurs on rolling, gravelly hills in a pinon-juniper-sagebrush community at about 1,900 meters (m) (6,200-6,300 feet (ft)).	The proposed uses of dicamba DGA are not expected to overlap with sagebrush habitats.	US FWS. 2010. Knowlton's Cactus (<i>Pediocactus knowltonii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3082.pdf
Kuenzler hedgehog cactus <i>(Echinocereus fendleri var. kuenzleri)</i>	Throughout its range, pinkflower hedgehog cactus occurs in desert grasslands, honey mesquite (<i>Prosopis glandulosa</i>) and other desert shrubland communities, pinyon-juniper (<i>Pinus-Juniperus</i> spp.) woodlands dominated mostly by Colorado pinyon (<i>P. edulis</i>) and oneseed juniper (<i>J. monosperma</i>), and pine-oak (<i>Quercus</i> spp.) woodlands. At the Desert Laboratory in Arizona, pinkflower hedgehog cactus grows in a creosotebush/triangle bursage (<i>Larrea tridentata</i> / <i>Ambrosia deltoidea</i>) community. In a 1941 survey, pinkflower hedgehog cactus was rare in the Colorado River canyon, where it was usually found in association with Engelmann's hedgehog cactus (<i>E. engelmannii</i>).	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1985. Recovery Plan for the Kuenzler's hedgehog cactus http://ecos.fws.gov/docs/recovery_plan/850328a.pdf
Ladies'-tresses, Ute (<i>Spiranthes diluvialis</i>)	Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations are found in riparian woodlands. Observed to be shade-intolerant (US FWS, 1995).	The proposed dicamba DGA uses are not expected to overlap with riverine, spring, or lakeside wet meadows.	USFWS. 1995. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/950921.pdf USFWS. Species Profile Page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2WA

	Occurs in relatively low elevation riparian, spring, and lakeside wetland meadows. Endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams. Occur primarily in areas where the vegetation is relatively open and not overly dense or overgrown, but some populations also found in riparian woodlands. Observed to be shade-intolerant (US FWS, Species Profile Page).		
Lee pincushion cactus <i>(Coryphantha sneedii var. leei)</i>	Chihuahuan desert scrub to conifer woodlands, rock outcrops (rarely alluvial rubble), usually narrowly confined to cracks in limestone	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1986. Recovery Plan for the Sneed and Lee Pincushion Cacti http://ecos.fws.gov/docs/recovery_plan/860321b.pdf
Leedy's roseroot <i>(Rhodiola integrifolia ssp. leedyi)</i>	New York populations occur on cliffs along the western shore of Seneca lake. In Minnesota, populations occur on moderate cliffs, which are cooled by air exiting underground passages in the karst topography (US FWS, 1998).	The proposed dicamba DGA uses are not expected to overlap with cliffs.	USFWS. 1998. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/980925.pdf
Lewton's polygala <i>(Polygala lewtonii)</i>	This plant grows on the sandhills of Central Florida and the transition between sandhill and Florida scrub. The land is dominated by longleaf pine, turkey oak, and other oaks. It can also be found in recently cleared areas such as the dry, open clearings around power lines.	The proposed dicamba DGA uses are not expected to overlap with sandhills.	US FWS. 2010. Lewton's polygala (<i>Polygala lewtonii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3261.pdf
Mancos milk-vetch <i>(Astragalus humillimus)</i>	Semi-arid sandstone rimrock ledges and mesa tops. Usually found on large, usually flat sheets of sandstone and is clustered around bowl-like depressions on the bedrock. Also found in cracks and fissures in the	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1989. Mancos milkvetch recovery plan http://ecos.fws.gov/docs/recovery_plan/891220.pdf

	sandstone and at the base of slickrock inclines.		
Mesa Verde cactus <i>(Sclerocactus mesae-verdae)</i>	In general, the cactus is restricted to the Mancos and Fruitland Shale Formations which have high alkalinity are gypsiferous and shrink-swell properties that make them harsh sites for plant life. The Mesa Verde cactus is most frequently found growing on the tops of hills or benches, slopes of hills and very rarely on level ground between the hills or benches.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1984. Mesa Verde Cactus Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/840330a.pdf
Miccosukee gooseberry (<i>Ribes echinellum</i>)	Mixed mesophytic hardwoods (USFWS 2008)	The proposed dicamba DGA uses are not expected to overlap with forests.	2008 US FWS Miccosukee Gooseberry 5-Year Review
Michaux's sumac (<i>Rhus michauxii</i>)	It is endemic to the inner coastal plain and piedmont of the Carolinas, Georgia, and Florida, where it occupies sandy or rocky open woods. It appears to depend upon some form of disturbance to maintain the open quality of its habitat. (USFWS 1993)	The proposed dicamba DGA uses are not expected to overlap with sandy or rocky open woods.	1993 USFWS RECOVERY PLAN for Michaux's Sumac (<i>Rhus michauxii</i>) Sargent
Navajo sedge <i>(Carex specuicola)</i>	Endemic to Navajo nation, and is now restricted to Navajo Sandstone Formation bedrock seep-spring pockets or in hanging gardens within the Great Basin conifer woodland at an elevation of 1740m to 1824 m. May have occurred in lower riparian areas in other canyons on the Navajo Nation. Grows in variety of situations, from inaccessible sheer cliff faces to accessible alcoves. Dominant associated species include monkey flower (<i>Mimulus eastwoodiae</i>), helleborine (<i>Epipactis gigantea</i>), water bentgrass (<i>Agrostis semiverticillata</i>), sand bluestem (<i>Andropogon hallii</i>), thistle (<i>Cirsium</i> spp.) Foxtail barley (<i>Hordeum</i>	The proposed uses of dicamba DGA are not expected to overlap with hanging garden habitats.	US FWS. 1987. Navajo Sedge (<i>Carex specuicola</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/870924.pdf

	jubatum), and common reed (<i>Phragmites communis</i>).		
Nichol's Turk's head cactus (<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>)	The cactus grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or shouldered next to rocks on steep slopes and within limestone outcrops.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2009. Nichol's Turk's Head Cactus (<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2509.pdf
North Park phacelia (<i>Phacelia formosula</i>)	Outcrops are rust-yellow sandstone and sandy areas along steep slopes, dissected by ravines, sparsely vegetated. More individuals are found on steep sided ravines. Other plants found in association include the genera <i>Mentzelia</i> , <i>Chrysothamnus</i> , <i>Oryzopsis</i> , <i>Arenaria</i> , <i>Eriogonum</i> , and <i>Rosa</i>	The proposed uses of dicamba DGA are not expected to overlap with steep slopes.	US FWS. 1986. North Park Phacelia (<i>Phacelia formosula</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/860321.pdf
Northeastern bulrush (<i>Scirpus ancistrochaetus</i>)	<p>Found in ponds, wet depressions, or shallow sinkholes within small (generally less than one acre) wetland complexes. These wetlands are characterized by seasonally variable water levels (p. i)</p> <p>In general, the northeastern bulrush tends to grow in acidic to circumneutral natural ponds, shall sinkholes, wet depressions (wet meadows and marshes) found in hilly country (p. 28).</p> <p>Wetlands occupied by the species in the northern part of its range do not appear to have any obvious unique habitat characteristics; indeed, many wetlands appear to have habitat suitable for the plant but do not harbor it (p. 28).</p> <p>Common to all of the ponds occupied by <i>S. ancistrochaetus</i>, however, are water levels that fluctuate seasonally and/or annually,</p>	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Recovery Plan http://ecos.fws.gov/docs/recovery_plan/930825.pdf

	from inundation (in late winter and spring) to saturation (in summer and late fall) (p. 28).		
Northern wild monkshood (<i>Aconitum noveboracense</i>)	Typical habitat is shaded to partially shaded cliffs and talus slopes or in New York, also occurs in semi-shaded seepage springs at high elevation headwaters. Various bedrock types from sandstones to dolomite and others act as substrates. All habitats have a cold soil environment associated with active and continuous cold air drainage or cold ground water flowage out of the nearby bedrock. Typically cliff and talus slope populations are associated with openings or caves, often ice-filled, through which the cold air emanates (US FWS, 1983, p. 18-20).	The proposed dicamba DGA uses are not expected to overlap with cliffsides, rockfalls at cliff bases or springs associated with cold air or water.	USFWS. 1983. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/830923.pdf
Osterhout milkvetch (<i>Astragalus osterhoutii</i>)	Middle Park desert badlands surrounded by high ranges of the Rocky Mountains and characterized by open grassy vegetation with scattered shrubs of big sagebrush, rabbitbrushes, bitterbrush, horsebrush, winterfat, snowberry, and/or mountain mahogany. Osterhout milkvetch shows evidence of light grazing and can be found on old road cuts and fills, Occur within six (6) miles to the north and east of the town of Kremmling.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1992. 1992_USFWS_Osterhout milkvetch (<i>Astragalus osterhoutii</i>) and penland beardtongue (<i>Penstemon penlandii</i>) recovery plan http://ecos.fws.gov/docs/recovery_plan/920930c.pdf

Pagosa skyrocket <i>(Ipomopsis polyantha)</i>	Shale outcrops— The Pagosa Skyrocket is limited to the Mancos Shale	The proposed uses of dicamba DGA are not expected to overlap with shale outcrops.	US FWS. . ECOS: Pagosa skyrocket (<i>Ipomopsis polyantha</i>) Species Profile - Life History http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q2U7#lifeHistory
Parachute beardtongue <i>(Penstemon debilis)</i>	Steep, continually shifting surface layers of broken shale rubble, along with sparse (less than 10 percent cover) vegetation of other oil shale-specific plants on the Parachute Creek Member and Lower Part of the Green River geologic formations. Rocky Mountain Cliff and Canyon plant community.	The proposed uses of dicamba DGA are not expected to overlap with shale outcrops.	US FWS. 2013. Recovery Outline Parachute beardtongue (<i>Penstemon debilis</i>) http://ecos.fws.gov/docs/recovery_plan/Parachute%20Beardtongue%20Recovery%20Outline.pdf
Pecos (=puzzle, =paradox) sunflower <i>(Helianthus paradoxus)</i>	Pecos sunflower is a wetland plant that grows on wet, alkaline soils at spring seeps, wet meadows, stream courses and pond margins. It has seven widely spaced populations in west-central and eastern New Mexico and adjacent Trans-Pecos Texas. These populations are all dependent upon wetlands from natural groundwater deposits. Incompatible land uses, habitat degradation and loss, and groundwater withdrawals are historic and current threats to the survival of Pecos sunflower. (USFWS 2005)	The proposed dicamba DGA uses are not expected to overlap with wetlands.	USFWS 2005 Final Pecos Sunflower Recovery Plan Available at: http://www.fws.gov/southwest/es/documents/r2es/pecos_sunflower_final_recovery_plan.pdf
Peebles Navajo cactus <i>(Pediocactus peeblesianus var. peeblesianus)</i>	The species occurs in desert habitat and the transition to Great Basin grassland habitat.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2008. Peebles Navajo Cactus(<i>Pediocactus peeblesianus</i> var. <i>peeblesianus</i>) 5-Year Review: Summary and Evaluation

			http://ecos.fws.gov/docs/five_year_review/doc1960.pdf
Penland alpine fen mustard (<i>Eutrema penlandii</i>)	small calcareous wetlands, Oligotrophic rheotrophic alpine marshes	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. <i>Eutrema penlandii</i> (Penland alpine mustard) Federal Register document http://ecos.fws.gov/docs/recovery_plan/920930c.pdf
Penland beardtongue (<i>Penstemon penlandii</i>)	<i>Penstemon penlandii</i> is found in co-existence with <i>Astragalus osterhoutii</i> and both are endemic to Middle Park, a high elevation sagebrush park at 7,500 feet, surrounded by various ranges of the Rocky Mountains, in Grand County, Colorado. It is found in badlands of Pierre Shales and of late Tertiary (Miocene Troublesome Formation) in siltstone sediments and the habitat is characterized by an open grassy vegetation with scattered shrubs of big sagebrush, rabbitbrushes, bitterbrush, horsebrush, winterfat, snowberry, and/or mountain mahogany	The proposed uses of dicamba DGA are not expected to overlap with sagebrush habitats.	US FWS. 1992. OSTERHOUT KILKVETCH (<i>Astragalus osterhoutii</i>) PENLAND BEARDTONGUE (<i>Penstemon penlandii</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/920930c.pdf
Peter's Mountain mallow (<i>Iliamna corei</i>)	<i>Iliamna corei</i> occurs in the shallow soil of the Clinch sandstone outcrops on the northwest-facing slope of Peters Mountain	The proposed uses of dicamba DGA are not expected to overlap with sandstone outcrops.	US FWS. 1990. Peters Mountain Mallow (<i>Iliamna corei</i>) (Sherli) Sherff) RECOVERY PLAN http://ecos.fws.gov/docs/recovery_plan/900928a.pdf
Pima pineapple cactus (<i>Coryphantha scheeri</i> var. <i>robustispina</i>)	Desert scrubland or the ecotone between desert scrubland and desert grasslands on flat terrain.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 2007. Pima Pineapple Cactus 5-Year Review Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1041.pdf
Roan Mountain bluet, (<i>Hedyotis purpurea</i> var. <i>montana</i>)	This species grows in shallow soils and crevices of cliffs and outcrops and on thin rocky soils of grassy balds (US FWS, 1996).	The proposed dicamba DGA uses are not expected to overlap with cliffs and outcrops.	USFWS. 1996. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/960513.pdf
Rock gnome lichen (<i>Gymnoderma lineare</i>)	Rock gnome lichen is primarily limited to vertical rock faces where seepage water from forest	The proposed dicamba DGA uses are not expected to overlap with high	http://www.fws.gov/raleigh/species/es_rock_gnome_lichen.html

	<p>soils above flows during (and only during) very wet times. It appears the species needs a moderate amount of light, but that it cannot tolerate high-intensity solar radiation. It does well on moist, generally open, sites, with northern exposures, but needs at least partial canopy coverage where the aspect is southern or western</p> <p>Rock gnome lichen is known from the Southern Appalachian Mountains of North Carolina and South Carolina, Tennessee, and Georgia, in areas of high humidity, either at high elevations, where it is frequently bathed in fog, or in deep gorges at lower elevations.</p>	elevation vertical rock faces where the species occurs.	
Running buffalo clover (<i>Trifolium stoloniferum</i>)	<p>Running buffalo clover occurs in mesic habitats of partial to filtered sunlight, where there is a prolonged pattern of moderate periodic disturbance, such as mowing, trampling, or grazing. It is most often found in regions underlain with limestone or other calcareous bedrock. Specific habitats include mesic woodlands, savannahs, floodplains, stream banks, sandbars, grazed woodlots, mowed paths (e.g. cemeteries, parks), old logging roads, jeep trails, ATV trails, skid trails, mowed wildlife openings within mature forest, and steep ravines. It has been suggested that the original habitat may have been open woods or</p>	The proposed dicamba DGA uses are not expected to overlap with mesic habitats where the clover is expected to be found.	USFWS. 2007. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/070627.pdf

	savannah, and bison herbivory on associated species may have kept the habitats open (US FWS, 2007, p. 12.).		
Sacramento Mountains thistle (<i>Cirsium vinaceum</i>)	Occur in wetlands, or subirrigated areas associated with springs, streams, and seeps. Most existing populations are in mixed conifer/mountain meadow settings. Riparian habitat on wet travertine deposits. It typically has meadows and streams on steep slopes with little other vegetation, including grass	The proposed uses of dicamba DGA are not expected to overlap with wetland habitats.	US FWS. 1993. Sacramento mountains thistle (<i>Cirsium vinaceum</i>) recovery plan. http://ecos.fws.gov/docs/recovery_plan/930927a.pdf
Sacramento prickly poppy (<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>)	Occurs in steep, rocky canyons between the pinyon/juniper zone of the Chihuahuan Desert Scrublands and Grasslands (1,310 m [4,300 ft]), and the lower edge of the ponderosa pine community of the Great Basin Conifer Woodlands (2,164 m [7,100 ft]). Habitats include arid canyon bottoms, dry terraces above riparian areas, and stream banks, as well as areas around springs and seeps. Plants grow directly in the rocks and gravel of stream beds; on vegetated bars of silt, gravel, and rock; on cut slopes; and on terraces above stream channels.	The proposed uses of dicamba DGA are not expected to overlap with canyon habitats.	US FWS. 2013. Sacramento prickly poppy 5-year review http://ecos.fws.gov/docs/five_year_review/doc4324.pdf
San Francisco Peaks ragwort (<i>Packera franciscana</i>)	Found on the talus slopes in the alpine fellfield on the San Francisco Peaks. 3,445-3,780 m. Ground surface is gravelly and existing boulders are more rounded with better lichen development than in the boulder field. Plant common in fine-medium grain soils on inclines from moderate to 60%; aspect ranged from 45-315 degrees, with largest population/greatest densities on slopes with aspects from	The proposed uses of dicamba DGA are not expected to overlap with alpine habitats.	US FWS. 1987. Recovery Plan for San Francisco Peaks Groundsel <i>Senecio franciscanus</i> Greene http://ecos.fws.gov/docs/recovery_plan/870721.pdf

	180-270 degrees. Vegetation here is of low stature, sparse, characterized by herbs, grasses, occasional shrubs, and at timberline by dwarf trees.		
Sandplain gerardii (<i>Agalinis acuta</i>)	Typically occurs on dry, sandy, poor-nutrient soils of sparsely vegetated sandplain environments and serpentine barrens. Lives in grassland communities.	The proposed uses of dicamba DGA are not expected to overlap with grassland habitats.	US FWS. 1989. Sandplain gerardia recovery plan http://ecos.fws.gov/docs/recovery_plan/890920.pdf
Scrub mint (<i>Dicerandra frutescens</i>)	<i>Dicerandra frutescens</i> is mostly restricted to excessively drained, yellow sandy soils of the Astatula and Paola soil types. However, it has been found on a moderately well-drained, yellow sand of the Orsino type. The plant requires periodic fire to maintain populations and populations decline in areas without fire in as little as five years. Row crop lands are expected to be maintained in a fireless state continually and it is not reasonable to assume that population of this species persist in row cropped areas.	The proposed 2,4-D choline use sites are not expected to provide appropriate fire influenced habitat.	US FWS. 2009. Scrub Mint (<i>Dicerandra frutescens</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2492.pdf
Seabeach amaranth (<i>Amaranthus pumilus</i>)	Barrier island beaches of the Atlantic coast, inlets, temporary habitats, may move as areas become suitable or unsuitable habitat. Overwash flats at accreting ends of islands, lower foredunes and upper strands of noneroding beaches (landward of the wrackline). Does not occur on well-vegetated sites. (USFWS 1996)	The proposed dicamba DGA uses are not expected to overlap with beaches.	1996 Weakley, Bucher, Murdock U.S. Fish and Wildlife Service. 1996. Recovery Plan for Seabeach Amaranth. (<i>Amaranthus pumilus</i>) Rafinesque). Atlanta, Georgia. http://ecos.fws.gov/docs/recovery_plan/961112b.pdf . 2007 USFWS Seabeach Amaranth Five-Year Review; http://ecos.fws.gov/docs/five_year_review/doc1068.pdf
Sensitive joint-vetch (<i>Aeschynomene virginica</i>)	Occurs in fresh to slightly brackish tidal river systems, within the intertidal zone where populations are flooded	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1995 USFWS Sensitive joint-vetch recovery plan 2012 USFWS Sensitive joint-vetch 5-year review

	<p>twice daily. Typically occur in the estuarine meander zone of tidal rivers where sediments transported from upriver settle out and extensive marshes form. Need disturbed/open habitats such as: accreting point bars that have not yet been colonized by perennial species, low swales within extensive marshes, areas of nutrient deficiencies in saturated organic sediments, or areas of muskrat herbivory. (USFWS 1995)</p> <p>Majority are found in natural tidal marsh habitats, but also a few documented cases of a pocket marsh wetland, edge of a moist soybean field, and a mowed grassy strip between a manmade drainage channel and dirt road. (USFWS 2012)</p>		
<p>Sentry milk-vetch (<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>)</p>	<p>Found on scarcely visible cracks in Kaibab limestone, in sand-filled hollows in rock, or on shallow gravelly soils.</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with limestone outcrops.</p>	<p>US FWS. 2009. Sentry milk-vetch 5-Year Review</p> <p>http://ecos.fws.gov/docs/action_plans/doc3054.pdf</p>
<p>Shale barren rock cress (<i>Arabis serotina</i>)</p>	<p>This plant grows on the soils of the restricted to shale barrens and adjacent woodlands found in western Virginia and eastern West Virginia.</p> <p>Shale barren is a designation for a shale slope of the region with an open, scrubby growth of pine, oak, red cedar, and other woody species adapted to the xeric conditions. Amidst the woody growth, which may form a canopy cover of less than 10%, an open herbaceous cover is found with species</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with shale barren or woodland habitats.</p>	<p>US FWS. 1991. SHALE BARREN ROCK (<i>Arabis serotina</i>) Recovery Plan</p> <p>http://ecos.fws.gov/docs/recovery_plan/910815.pdf</p>

	also adapted to the harsh conditions.		
Siler pincushion cactus (<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>)	Badland like rolling hills.	The proposed uses of dicamba DGA are not expected to overlap with desert habitats.	US FWS. 1986. Recovery Plan for the <i>Pediocactus sileri</i> http://ecos.fws.gov/docs/recovery_plan/860414b.pdf
Small-anthered bittercress (<i>Cardamine micranthera</i>)	Native to small streambank seeps, adjacent sandbars, and stream edges in the Dan River drainage of the North Carolina and Virginia piedmont. (USFWS 1991) This plant occurs in moist and wet, shady areas near streams and in dim woodlands. Small-anthered bittercress is known only from the Dan River basin in north-central North Carolina (Stokes County) and south-central Virginia (Patrick County). (USFWS 1998)	The proposed dicamba DGA uses are not expected to overlap with stream edges.	1991 USFWS Recovery Plan for the Small-anthered bittercress <i>Cardamine micranthera</i> 1998 USFWS Recovery Plan for the <i>Cardamine micranthera</i>
Small whorled pogonia (<i>Isotria medeoloides</i>)	The small whorled pogonia occurs on upland sites in mixed-deciduous or mixed deciduous/coniferous forests that are generally in second- or third-growth successional stages. It occurs on both fairly young and maturing forest stands. Most occurrences include sparse to moderate ground cover in the species' microhabitat, a relatively open understory canopy, and proximity to features that create long persisting breaks in the forest canopy. Soils at most sites are highly acidic and nutrient poor, with moderately high soil	The proposed dicamba DGA uses are not expected to overlap with mixed deciduous/coniferous forests.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113b.pdf

	moisture values. Light availability could be a limiting factor for this species. The one Illinois site is unusual in being on a dry, steep, thinly forested slope atop a vertical sandstone bluff. The one Ohio site is along the Ohio River in a typical Appalachian-type forest association (US FWS, 1992, pp. 23-24).		
Smooth coneflower (<i>Echinacea laevigata</i>)	The habitat of smooth coneflower consists of open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium- and calcium-rich soils associated with amphibolite, dolomite, or limestone (USFWS 2011)	The proposed dicamba DGA uses are not expected to overlap with open woods, barrens, or bluffs.	2011 USFWS Smooth Coneflower (<i>Echinacea laevigata</i>) 5-Year Review: Summary and Evaluation
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)	The Sneed and Lee pincushion cacti grow in semi-desert grassland (Brown, 1982). The Sneed pincushion cactus is restricted to limestone and grows in cracks on vertical cliffs or ledges. The Sneed pincushion cactus grows at an elevation of 1,200-2,350 m in areas where the average precipitation varies from 19.7 to 40 cm per year. Edaphic requirements are poorly understood. (USFWS 1986)	The proposed dicamba DGA uses are not expected to overlap with semi-desert grasslands.	1986 USFWS Recovery Plan for the Sneed and Lee Pincushion Cacti. Pages 8-9. Available at: http://ecos.fws.gov/docs/recovery_plan/860321b.pdf
Swamp pink (<i>Helonias bullata</i>)	Swamp pink is found in a variety of wetland habitats, including swampy forested wetlands bordering small streams; headwater wetlands; sphagnous, hummocky, dense Atlantic white cedar swamps; Blue Ridge swamps; meadows; bogs;	The proposed dicamba DGA uses are not expected to overlap with wetlands.	1991 USFWS Swamp Pink (<i>Helonias bullata</i>) Recovery Plan Available at: http://ecos.fws.gov/docs/recovery_plan/910930c.pdf

	and spring seepage areas (USFWS 1991)		
Todsen's pennyroyal (<i>Hedeoma todsenii</i>)	<p>Todsen's pennyroyal occurs in the Great Basin Conifer Woodland community where piñon pine (<i>Pinus edulis</i>) and one seed juniper (<i>Juniperus monosperma</i>) are the dominant species (Brown and Lowe 1980). Besides piñon and juniper, other common associates with Todsen's pennyroyal include mountain mahogany (<i>Cercocarpus montanus</i>), yellowleaf silktassel (<i>Garrya flavescens</i>), wavyleaf oak (<i>Quercus undulata</i>), white ragweed (<i>Hymenopappus radiatus</i>), snakeweed (<i>Gutierrezia</i> sp.), and muhly grass (<i>Muhlenbergia</i> sp.). Todsen's pennyroyal does not appear to associate consistently with any particular species. It grows (and flowers) in the shade of piñon pines and junipers, and in woodland openings with thin grasses (mostly <i>Muhlenbergia</i> sp.). At some sites, it is absent from thickets of wavyleaf oak; at other sites, flowering plants are under wavyleaf oak and other shrubs (The Nature Conservancy, New Mexico Field Office 1990; Sarah Wood, pers. comm. 1993). Todsen's pennyroyal is restricted to loose, gypseous-Plants grow in loose limestone substrates associated with or positioned gypseous-limestone immediately below the Permian Yeso Formation soils on north-facing (NMFRCD 1991) Most plants are on steep (20-70 degree), north-facing slopes, with a surface of scree or</p>	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	<p>US FWS. 2001. Todsen's Pennyroyal Recovery Plan - 2001</p> <p>http://ecos.fws.gov/docs/recovery_plan/010131.pdf</p>

	gravelly cobble; however, some plants at Mountain Lion Peak are on small, nearly level terraces along intermittent streams. The substrates have a thin layer of conifer litter over a mixture of limestone and finer materials.		
Virginia round-leaf birch (<i>Betula uber</i>)	Transitional between the oak-pine and maple-beech-birch associations, with some tendencies toward the elm-ash-cottonwood association because of the riparian setting. Disturbance and moderate levels of incoming solar radiation associated with seedling establishment	The proposed uses of dicamba DGA are not expected to overlap with forest habitats.	US FWS. 1990. 1990_USFWS_Virginia round-leaf birch (<i>Betula uber</i>) recovery plan http://ecos.fws.gov/docs/recovery_plan/900924a.pdf
Virginia sneezeweed (<i>Helenium virginicum</i>)	Seasonal wetlands, sink hole ponds varying from forest settings to farm pond margins.	The proposed dicamba DGA uses are not expected to overlap sink hole ponds and seasonal wetlands.	http://ecos.fws.gov/docs/recovery_plan/001002.pdf
Spiraea, Virginia (<i>Spiraea virginiana</i>)	<i>Spiraea virginiana</i> is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). The habitat is in oft-disturbed early successional areas. Occasional flood scouring reduces shading and seems to be essential, although the spiraea can tolerate some overstory growth (US FWS, 1992, pp.17-18.).	The proposed dicamba DGA uses are not expected to overlap with rivers, streams, creeks, or other water bodies.	USFWS. 1992. Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/921113a.pdf
Welsh's milkweed (<i>Asclepias welshii</i>)	Aeolian sand dunes in a plant community dominated by sand mulesears with prominent groves of ponderosa pine and clumps of Gambel oak. Vegetation surrounding the sand dune habitat is dominated by	The proposed uses of dicamba DGA are not expected to overlap with woodland or sagebrush habitats.	US FWS. 1992. Welsh's Milkweed (<i>Asclepias welshii</i>) Recovery Plan http://ecos.fws.gov/docs/recovery_plan/920930a.pdf

	pinon-juniper woodlands with sagebrush.		
Zuni fleabane <i>(Erigeron rhizomatus)</i>	Found on red detrital clay with steep easily erodable slopes that do not crust over. Associated with pinon-juniper woodland. Prefers slopes of up to 40 degrees, usually with a north-facing aspect, but it also occurs on eastern and western exposures. It never occurs on slopes with a southern aspect.	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats.	US FWS. 1988. Zuni fleabane recovery plan http://ecos.fws.gov/docs/recovery_plan/880930.pdf
Aboriginal Prickly-apple <i>(Harrisia aboriginum)</i>	This cactus occurs in Florida in coastal strand vegetation (relatively low salt-tolerant shrubs and grasses), tropical coastal hammocks with trees including gumbo limbo (<i>Bursera simaruba</i>), wild lime (<i>Zanthoxylum fagara</i>), or live oak (<i>Quercus virginiana</i>). Populations are likely to be on shell mounds created by pre-European local residents, or at least on sites with shelly substrates. Plants may be quite close to the mangrove zone	The proposed uses of dicamba DGA are not expected to overlap with habitats on shelly substrates or vegetation that is at all salt-tolerant.	US FWS. Species life history page. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q0DR
Apalachicola rosemary <i>(Conradina glabra)</i>	Xeric longleaf pine communities; prefers sunny or lightly shaded areas. Edges of steephead ravines, upland pine-wiregrass vegetation, also found in right-of-ways, edges of roads in pine plantations	The proposed uses of dicamba DGA are not expected to overlap with woody habitats.	US FWS. 2009. <i>Conradina glabra</i> (Apalachicola rosemary) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2421.pdf
Avon Park harebells <i>(Crotalaria avonensis)</i>	Sparsely vegetated, xeric white sand scrub. Prefers (but does not require) open scrub, with less vegetation cover and more bare sand.	The proposed uses of dicamba DGA are not expected to overlap with scrubland habitats or areas of bare sand.	Avon Park harebells (<i>Crotalaria avonensis</i>) 5-Year Review: Summary and Evaluation US FWS. 2007. http://ecos.fws.gov/docs/five_year_review/doc1067.pdf
Beach jacquemontii <i>(Jacquemontia reclinata)</i>	<i>Jacquemontia reclinata</i> requires open areas that are typically found on the crest and lee sides of stable dunes (Austin 1979), and may also invade and restabilize maritime hammock or coastal strand communities that have been disturbed by tropical storms, hurricanes, and	The proposed uses of dicamba DGA are not expected to overlap with sand dune or maritime habitats.	US FWS. 1999. South Florida Field Office Multi-Species Recovery Plan http://ecos.fws.gov/docs/recovery_plan/140903.pdf

	possibly fire. Common vegetative associates found with <i>J. reclinata</i> include sea grape (<i>Coccoloba uvifera</i>), cabbage palm (<i>Sabal palmetto</i>), poisonwood (<i>Metopium toxiferum</i>), Madagascar periwinkle (<i>Catharanthus roseus</i>), Croton involucrata, gopher apple (<i>Licania michauxii</i>), prickly pear cactus (<i>Opuntia</i> sp.), sandspurs (<i>Cenchrus</i> spp.), sea oats (<i>Uniola paniculata</i>) and other shrubs and dwarfed trees. It is also an inhabitant of disturbed or sunny areas In the tropical maritime hammock (hardwood forest) or the coastal strand vegetation, typically with sea grape (<i>Coccoloba uvifera</i>) and other shrubs and dwarfed trees. It usually occurs with more or less weedy plants such as Madagascar periwinkle (<i>Catharanthus roseus</i>) and sand spurs (<i>Cenchrus</i> spp.). It occasionally occurs in the beach dune community with sea oats (<i>Uniola paniculata</i>).		
Beautiful pawpaw (<i>Deeringothamnus pulchellus</i>)	Pristine and modified pine flatwoods, roadsides, and mowed areas	The proposed uses of dicamba DGA are not expected to overlap with woodland habitats or roadsides and mowed areas.	US FWS. 2009. Beautiful pawpaw (<i>Deeringothamnus pulchellus</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2588.pdf
Britton's beargrass (<i>Nolina brittoniana</i>)	Occurs in scrub, high pineland, and even occasionally in hammocks.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or woodland habitats.	US FWS. 1996. Recovery Plan for Nineteen Central Florida Scrub and High Pineland Plants (revised) (960622) http://ecos.fws.gov/docs/recovery_plan/960622.pdf
Brooksville bellflower (<i>Campanula robinsiae</i>)	Deciduous forest: Occurs on pond margins, wet prairies, and seepage areas in adjacent hardwood forests, Also along the margins of marshes. Important characteristic is	The proposed uses of dicamba DGA are not expected to overlap with forested or wetland habitats	US FWS. 1994. Recovery plan Brooksville bellflower (<i>Campanula robinsiae</i>) and Cooley's water willow (<i>Justicia cooleyi</i>).

	that the water line fluctuates. Often the Brooksville bellflower's habitat is surrounded by pastures		http://ecos.fws.gov/docs/recovery_plan/940620b.pdf
Cape Sable Thoroughwort (<i>Chromolaena frustrata</i>)	Grows in open canopy habitats in coastal berms and coastal rock barrens, and in semi-open to closed canopy habitats, including buttonwood forests, coastal hardwood hammocks, and rockland hammocks. <i>C. frustrata</i> is often found in the shade of associated canopy and subcanopy plant species	The proposed uses of dicamba DGA are not expected to overlap with coastal or woodland habitats	US FWS. 2014. Designation of Critical Habitat for <i>Chromolaena frustrata</i> (Cape Sable Thoroughwort); Final Rule http://www.gpo.gov/fdsys/pkg/FR-2014-01-08/pdf/2013-31576.pdf
Carter's mustard (<i>Warea carteri</i>)	Found almost exclusively in upland areas. It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. Near the south end of its range (e.g., ABS), Carter's mustard is found primarily in scrubby flatwoods. Also grows along sandy trails and roadsides.	The proposed uses of dicamba DGA are not expected to overlap with sandhills or flatwoods habitats.	US FWS 2008. Carter's mustard (<i>Warea carteri</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1977.pdf
Chapman rhododendron (<i>Rhododendron chapmanii</i>)	Transitional area between upland mesic or scrubby flatwoods and floodplain swamps or baygalls. Also found in mesic pine flatwoods or on the lower elevations of sandhills. Fire dependent community. Camp Blanding population grows on the edge of a xeric hammock next to a stream bank. The Camp Blanding sites are dominated by sand live oak (<i>Quercus germinata</i>), laural oak (<i>Q. hemisphaerica</i>), and water oak (<i>Q. nigra</i>). Gulf and Liberty/Gadsden populations are dominated by wiregrass, longleaf pine and/or slash pine.	The proposed uses of dicamba DGA are not expected to overlap with wetland or woodland habitats and are not expected to be associated with frequent fires.	US FWS. 2010. Chapman's Rhododendron (<i>Rhododendron minus</i> var. <i>chapmanii</i>) 5 year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc3201.pdf

Cooley's water-willow <i>(Justicia cooleyi)</i>	Hardwood forests and hardwood pine forests. Also found along roadways among species of various grasses and herbs.	The proposed uses of dicamba DGA are not expected to overlap with forested habitats or along roadways.	US FWS. 1994. Brooksville bellflower and Cooley's water-will recovery plan. http://ecos.fws.gov/docs/recovery_plan/940620b.pdf
Crenulate lead-plant <i>(Amorpha crenulata)</i>	Historically, this species occupied the ecotone between wet prairie and pine rockland, but wet prairie habitat no longer exists in the sites containing the two largest natural populations, and pine rockland is rare. Prefers open sun to partial shade sites.	The proposed uses of dicamba DGA are not expected to overlap with wetland, forested or rockland habitats.	US FWS. 2007. Crenulate lead-plant (<i>Amorpha crenulata</i>) 5-Year Review: Summary and Evaluation. http://ecos.fws.gov/docs/five_year_review/doc1111.pdf
Deltoid spurge <i>(Chamaesyce deltoidea ssp. deltoidea)</i>	Pine rocklands of Miami Rock Ridge. Open shrub canopy, exposed limestone, and minimal litter	The proposed uses of dicamba DGA are not expected to overlap with wooded habitats and exposed soils.	US FWS. 2010. Deltoid Spurge (<i>Chamaesyce deltoidea ssp. deltoidea</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3243.pdf
Etonia rosemary <i>(Conradina etonia)</i>	Deep white sand scrub with shrubby evergreen oaks and sand pines; occur in natural openings/disturbed areas	The proposed uses of dicamba DGA are not expected to overlap with scrubland wooded habitats	US FWS. 1994. Etonia rosemary recovery plan http://ecos.fws.gov/docs/recovery_plan/940927c.pdf
Florida bonamia <i>(Bonamia grandiflora)</i>	Occurs mainly in scrub, but occasionally occurs in high pinelands in the Ocala National Forest (pg 14); In Ocala National Forest, the bonamia has been observed in the following stand condition classes of sand pine: regeneration, seedling and sapling, immature poletimber, mature poletimber (pg 15).	The proposed uses of dicamba DGA are not expected to overlap with scrubland or wooded habitats.	US FWS. 1996. Recovery Plan for Nineteen Central Florida Scrub and High Pineland Plants (revised) (960622) http://ecos.fws.gov/docs/recovery_plan/960622.pdf
Florida golden aster <i>(Chrysopsis floridana)</i>	Prefers open, sandy areas within the sand pine scrub community. They have been found growing in the ecotone between scrub and other communities. Historically, <i>C. floridana</i> was known to occur in scrub habitat on coastal dunes, and was reintroduced to this habitat type at Fort Desoto County Park.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or wooded habitats.	US FWS. 2009. Florida Golden-aster 5-year review http://ecos.fws.gov/docs/five_year_review/doc2411.pdf

Florida perforate cladonia (<i>Cladonia perforata</i>)	This lichen occurs on a barrier island in the Florida panhandle (Okaloosa County) and in scrub vegetation	The proposed uses of dicamba DGA are not expected to overlap with barrier island or scrubland habitats.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.) http://ecos.fws.gov/docs/recovery_plan/140903.pdf
Florida Semaphore Cactus (<i>Consolea corallicola</i>)	Occurs on rockland hammocks; coastal berm, and buttonwood forests. <i>Consolea corallicola</i> also occurs on sandy soils and limestone rockland soils with little organic matter and seems to prefer areas where canopy cover and sun exposure are moderate.	The proposed uses of dicamba DGA are not expected to overlap with rocky, coastal or wooded habitats.	US FWS. 2013. Determination of Endangered Status for <i>Chromolaena frustrata</i> (Cape Sable Thoroughwort), <i>Consolea corallicola</i> (Florida Semaphore Cactus), and <i>Harrisia aboriginum</i> (Aboriginal Prickly-Apple); Final Rule http://www.gpo.gov/fdsys/pkg/FR-2013-10-24/pdf/2013-24177.pdf
Florida skullcap (<i>Scutellaria floridana</i>)	The primary habitat of Florida skullcap is wet longleaf pine flatwoods and wet prairie, within the grassy seepage bog communities at the edge of forested or shrubby wetlands, a habitat defined as a fire-dependent community. It is also found in the ecotones between mesic flatwoods and swamps sites or grassy margins of wetland habitats, and somewhat disturbed wetland savanna. Florida skullcap can be found growing in full sun or light shade.	The proposed uses of dicamba DGA are not expected to overlap with wetland or forested habitats or in areas with frequent fire disturbance.	US FWS. 2009. <i>Scutellaria floridana</i> (<i>Florida skullcap</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2416.pdf
Florida torreya (<i>Torreya taxifolia</i>)	The Florida torreya is a dioecious coniferous tree found in the slope forest (FNAI 2010) that cover hammocks, steep, deeply shaded limestone slopes and wooded ravines along the east side of the Apalachicola River in Florida (Fig. 1), and adjacent Lake Seminole in Georgia. Soils in these areas are within the orders Alfisols and Mollisols. (USFWS 2010)	The proposed dicamba DGA uses are not expected to overlap with forests.	USFWS 2010. <i>Torreya taxifolia</i> (<i>Florida torreya</i>) 5-Year Review. Page 13. Available at: http://ecos.fws.gov/docs/five_year_review/doc3258.pdf
Florida ziziphus	Seems to prefer high pine habitats or the transition zone	The proposed uses of dicamba DGA are not	US FWS. 2009. Florida Ziziphus

<i>(Ziziphus celata)</i>	between scrubby flatwoods and high pine. In general habitat characterization for this particular species is extremely complexed. Many of the known sites are in pasture and one site in particular is identified as a Remnant Sandhill. Another site in particular is described as open Oak Hickory, yellow sand scrub.	expected to overlap with wooded habitats.	<i>(Ziziphus celata)</i> 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2587.pdf
Four-petal pawpaw <i>(Asimina tetramera)</i>	Found on sand pine scrub vegetation on old, coastal dunes 1979). The species grows in excessively-drained, quartz sand of both the Paola and the St. Lucie soil series showing a preference for the Paola soils. <i>Asimina tetramera</i> is found in various seral stages of sand pine scrub, ranging from open [no canopy] to mature [closed canopy] and is adapted to infrequent, intense fires, perhaps every 20 to 80 years.	The proposed uses of dicamba DGA are not expected to overlap with scrubland or wooded habitats.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.) http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Fragrant prickly-apple <i>(Cereus eriophorus var. fragrans)</i>	The plant's favored natural habitat is mostly coastal hammocks with some shade, as the cactus can become desiccated in full sun. Coastal hammocks of this kind have become uncommon as they have been cleared for development and heavily fragmented	The proposed uses of dicamba DGA are not expected to overlap with coastal habitats with shade.	US FWS. 2010. Fragrant prickly-apple (<i>Cereus eriophorus</i> var. <i>fragrans</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3246.pdf
Garber's spurge <i>(Chamaesyce garberi)</i>	Garber's spurge occurs at low elevations either on thin sandy soils composed largely of Pamlico sands or directly on limestone. It is found in a variety of open to moderately shaded habitat types. In pine rocklands, it grows out of crevices in oolitic limestone. On Cape Sable, Everglades NP, it has been reported from hammock edges, open grassy prairies, and backdune swales. In the Florida Keys, it grows on semi-exposed limestone shores, open calcareous salt flats, pine rocklands, calcareous sands	The proposed dicamba DGA uses are not expected to overlap with pine rocklands, limestone crevices, the Everglades National Park, and the Florida Keys.	US FWS. 1999. South Florida Multi-Species Recovery Plan (68 spp.) http://ecos.fws.gov/docs/recovery_plan/140903.pdf

	of beach ridges, and along disturbed roadsides.		
Garrett's mint <i>(Dicerandra christmanii)</i>	<i>Dicerandra christmanii</i> is found within openings in sclerophyllous oak scrub. As a gap species, it prefers open areas and does not grow vigorously when in shaded conditions. The habitat is yellow-sand Florida scrub dominated by sand pines (<i>Pinus clausa</i>), several species of oak, and scrub hickory.	The proposed dicamba DGA uses are not expected to overlap with oak scrub, sand pines, and scrub hickory.	US FWS 2009. Garrett's Mint (<i>Dicerandra christmanii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2545.pdf
Godfrey's butterwort <i>(Pinguicula ionantha)</i>	Occurs in herb bog habitats embedded in longleaf pine savannas. Specifically, it is found between a lower elevation habitat dominated by pond cypress overstory and a slightly higher elevation pine flatwoods dominated by an overstory of longleaf pine. This species inhabits seepage bogs, deep swampy bogs, ditches, and depressions in grassy pine flatwoods and savannas (p. 11).	The proposed dicamba DGA uses are not expected to overlap with longleaf pine savannas.	US FWS. 2009. <i>Pinguicula ionantha</i> Godfrey's butterwort 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2590.pdf
Harper's beauty <i>(Harperocallis flava)</i>	Gentle slopes, seepage savannas between pinelands, and cypress swamps to open roadside depressions. Observed in pine flatwoods bog areas surrounded with titi (<i>Cyrilla racemiflora</i>), wiregrass (<i>Aristida stricta</i>), and slash pine (<i>Pinus elliottii</i>), along roadsides, in damp roadside ditches adjacent to planted pines near flatwoods. Wet prairie in transitions to wetter shrub zones and roadside ditches. Wet prairie is characterized as a treeless plain with sparse to dense ground cover of grasses and herbs, dominated by wiregrass in the Apalachicola NF; low relatively flat poorly drained terrain of the coastal plain, seasonally inundated for 50-100 days each years, burns every 2-4 years. Fire prone habitat.	The proposed uses of dicamba DGA are not expected to overlap with savannas and pine flatwoods bog areas.	US FWS. 2009. <i>Harperocallis flava</i> Harper's beauty 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc2579.pdf

Highlands scrub hypericum (<i>Hypericum cumulicola</i>)	Highlands scrub hypericum is found almost exclusively in upland areas with excessively-drained white sand. It is found primarily in rosemary scrub but also in xeric scrubby flatwoods. These areas have fire return intervals of 5-30 years or 10-100 years. The species is not found in all areas of suitable habitat probably because of dispersal limitations.	The proposed dicamba DGA uses are not expected to overlap with white sand areas.	US FWS 2008. beauty Highlands scrub hypericum (<i>Hypericum cumulicola</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1959.pdf
Johnson's seagrass (<i>Halophila johnsonii</i>)	Estuarine/Marine Submerged Environments. Lagoons along approximately 200 km of coastline in southeastern Florida between Sebastian Inlet and north Biscayne Bay. Extending from intertidal to 3m of depth	The proposed dicamba DGA uses are not expected to overlap with lagoons and other aquatic habitats.	US FWS. 2002. Endangered and Threatened Species; Notice of Availability for the Final Recovery Plan for Johnson's Seagrass http://ecos.fws.gov/docs/federal_register/fr3965.pdf
Key tree cactus (<i>Pilosocereus robinii</i>)	This cactus grows in upland tropical hardwood hammocks on limestone or coral substrates. It sometimes grows on sparsely vegetated coral rock and just above the high tide mark.	The proposed dicamba DGA uses are not expected to overlap with upland tropical hardwood hammocks on limestone or coral substrates.	US FWS. 2010. Key tree-cactus (<i>Pilosocereus robinii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3278.pdf
Knieskern's Beaked-rush (<i>Rhynchospora knieskernii</i>)	Occurs in groundwater-influenced, fluctuating, successional habitats. Found on bare substrates with sparse vegetation. Requires disturbance and is an early successional species. Historical records indicate species occupied wet open areas in fire-dependent pitch pine forests. Species is now found in human-influenced sites such as the edges of abandoned clay, sand, and gravel pits; borrow pits that are functioning as vernal pools; ditches; unimproved roads; cranberry bogs; and railroad and powerline rights-of-way	The proposed dicamba DGA uses are not expected to overlap with the edges of abandoned clay, sand, and gravel pits; borrow pits that are functioning as vernal pools; ditches; unimproved roads; cranberry bogs; and railroad and powerline rights-of-way.	US FWS. 1993. Knieskern's Beaked-rush (Ii) Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/930929b.pdf
Lakela's mint (<i>Dicerandra immaculata</i>)	<i>Dicerandra immaculata</i> is found in open scrub, sand pine scrub, and sandhills on remnants of old coastal dunes.	The proposed uses of dicamba DGA are not expected to overlap with scrub and sandhills habitats.	US FWS. 2008. Lakela's mint (<i>Dicerandra immaculata</i>) 5-Year Review: Summary and Evaluation

			http://ecos.fws.gov/docs/five_year_review/doc1984.pdf
<p>Longspurred mint</p> <p>(<i>Dicerandra cornutissima</i>)</p>	<p>Endemic to sand pine scrub habitat of Florida. Occurs southwest of Ocala in the Sumter Upland in Marion County along and west of Interstate Highway 75 and formerly in northern Sumter County. The longspurred mint prefers sunny spots with bare sand. The plant is restricted to the margins of scrub vegetation that occurs in patches surrounded by long leaf pine-turkey oak sandhill vegetation</p>	<p>The proposed dicamba DGA uses are not expected to overlap with sand pine scrub habitat.</p>	<p>US FWS. 1987. Recovery Plan for Three Florida Mints.</p> <p>http://ecos.fws.gov/docs/recovery_plan/060313d.pdf</p>
<p>Okeechobee gourd</p> <p>(<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>)</p>	<p>Lake Okeechobee and the other along the St. Johns River. Limited to areas along the shoreline and a few islands in the lake and along the St. Johns River</p>	<p>The proposed dicamba DGA uses are not expected to overlap with lakes and rivers.</p>	<p>US FWS. 2009. Okeechobee gourd (<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>) 5-Year Review: Summary and Evaluation</p> <p>http://ecos.fws.gov/docs/five_year_review/doc2583.pdf</p>
<p>Papery whitlow-wort</p> <p>(<i>Paronychia chartacea</i>)</p>	<p>Rosemary scrub, or the rosemary phase of sand pine scrub. The fire cycle in rosemary scrub can range from 10 to as long as 100 years</p> <p>The shrub matrix is interspersed with open sandy areas that contain a cover of herbs and lichens. These gaps are more persistent in rosemary scrubs than in scrubby flatwoods.</p> <p>Within these scrub communities, papery whitlow-wort is more abundant in disturbed, sandy habitats such as road rights-of-way and recently cleared high Pine. In rosemary scrub paper whitlow-wort can become very abundant after a fire or on disturbed sites such as along fire lanes or trails.</p> <p>The subspecies <i>P. chartacea</i> ssp. <i>minima</i> occurs in the Florida panhandle in coarse white sand along margins of</p>	<p>The proposed uses of dicamba DGA are not expected to overlap with rosemary scrub or sand pine scrub.</p>	<p>US FWS. 1999. Multi-Species Recovery Plan for South Florida</p> <p>http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf.</p>

	karst lakes (Anderson 1991). It is apparently favored by mild disturbance. It often occurs in nearly pure stands.		
Pigeon wings (<i>Clitoria fragrans</i>)	Range of xeric upland sites. Primarily in sandhill and oak-hickory scrub or oak scrub.	The proposed dicamba DGA uses are not expected to overlap with sandhill or scrub habitats.	US FWS. 2008. Pigeon wings (<i>Clitoria fragrans</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1976.pdf
Pygmy fringe-tree (<i>Chionanthus pygmaeus</i>)	Inhabits excessively drained sandy soils on the Lake Wales Ridge (and historically on the Mount Dora Range) of central Florida. These high ridges are blanketed with soils that are classified as Quartzipsamments. This species is found on the low-nutrient St. Lucie fine sand which is subject to rapid drying. <i>Chionanthus pygmaeus</i> occurs primarily in scrub as well as high pine, dry hammocks, and transitional habitats. It may form thickets along with evergreen oaks and other shrubs. It may be the dominant plant, co-dominant plant or subdominant plant.	The proposed dicamba DGA uses are not expected to overlap with scrub and hammocks.	US FWS. 1999. Multi-Species Recovery Plan for South Florida http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
Rugel's pawpaw (<i>Deeringothamnus rugelii</i>)	Grassy flatlands/mesic/wet flatwoods at Volusia County conservation land. The habitat at this site is dominated by mature longleaf pine and an intact groundcover, which frequently includes wiregrass in abundance. Open sandy patches that have been controlled under natural situations with fire. Fire is needed to create habitat for this species. Slash pine flatwoods with an understory consisting of grasses and sedges	The proposed dicamba DGA uses are not expected to overlap with flatwoods habitats.	US FWS. 2008. Rugel's pawpaw (<i>Deeringothamnus rugelii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1990.pdf
Sandlace (<i>Polygonella myriophylla</i>)	This plant is a member of the Florida scrub plant community. It occurs in dry white-sand scrub dominated by Florida rosemary, as well as oak scrub, flatwoods,	The proposed dicamba DGA uses are not expected to overlap with scrub communities	US FWS. 2010. Sandlace (<i>Polygonella myriophylla</i>) 5-Year Review: Summary and Evaluation.

	roadsides, and occasionally sandhills		http://ecos.fws.gov/docs/five_year_review/doc3277.pdf
Scrub blazingstar <i>(Liatris ohlingerae)</i>	Occurs in rosemary scrub or 'rosemary balds' as they are also known, is a unique community type within the Florida scrub ecosystem. Rosemary scrub is largely dominated by Florida rosemary (<i>Ceratiola ericoides</i>) and has extremely well-drained, droughty, low-nutrient sandy soils. Rosemary scrub appears as small 'islands' separated from each other, often by considerable distances. Scrubby flatwoods often surround rosemary scrub, dominated by clonal oaks (<i>Quercus</i> spp.). Also colonizes anthropogenic sites within its natural habitat, such as fire lanes and roadsides. Occurrences of scrub blazingstar are generally small, with scattered plants at low densities over large areas.	The proposed dicamba DGA uses are not expected to overlap with rosemary scrub or rosemary balds habitat.	US FWS. 2010. Scrub Blazingstar (<i>Liatris ohlingerae</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3269.pdf
Scrub buckwheat <i>(Eriogonum longifolium</i> var. <i>gnaphalifolium)</i>	Scrub buckwheat occurs in habitats intermediate between scrub and sandhills (high pine) and in turkey oak barrens from Putnam County to Highlands County).	The proposed dicamba DGA uses are not expected to overlap with scrub and sandhills habitat.	US FWS. 2010. Scrub buckwheat (<i>Eriogonum longifolium</i> var. <i>gnaphalifolium</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1926.pdf
Scrub lupine <i>(Lupinus aridorum)</i>	Coastal scrub habitat in two distinct areas: Western Orange County (Orlando area) and North-central Polk County on the Winter Haven Ridge near Auburndale and Winter Haven, on sites that total only about 540 acres.	The proposed dicamba DGA uses are not expected to overlap with coastal scrub habitat.	US FWS. 1996. Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species. http://ecos.fws.gov/docs/recovery_plan/960622.pdf
Scrub plum <i>(Prunus geniculata)</i>	Found in both scrub and high pineland. It should probably be sought in ecotones or scrubby high pineland. (pg. 33)	The proposed dicamba DGA uses are not expected to overlap with scrub and high pineland.	US FWS. 1996. Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species. http://ecos.fws.gov/docs/recovery_plan/960622.pdf

Short-leaved rosemary <i>(Conradina brevifolia)</i>	This plant grows in Florida scrub habitat on white sand substrates among sand pines and oaks.	The proposed dicamba DGA uses are not expected to overlap with scrub habitat.	US FWS. 2008. Short-leaved rosemary (<i>Conradina brevifolia</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1943.pdf
Small's milkpea <i>(Galactia smallii)</i>	Pine Rockland habitat. Small's milkpea prefers open sun and little shade and can be threatened by shading from hardwoods and displacement by invasive exotic species in the absence of periodic fires. Disturbance, such as prescribed fire, is a necessary management tool to maintain suitable habitat for the species	The proposed dicamba DGA uses are not expected to overlap with pine rockland habitat.	US FWS. 2010. Small's Milkpea (<i>Galactia smallii</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3257.pdf
Snakeroot <i>(Eryngium cuneifolium)</i>	Open sand gaps in white sand scrub, primarily Florida rosemary scrub 'balds', characterized by xeric conditions, relatively sparse vegetation, persistent gaps, and longer fire-return intervals than oak (<i>Quercus</i> spp.) and sand pine (<i>Pinus clausa</i>) dominated scrubs (pg. 6); restricted to open areas of well-drained white sand in Florida rosemary scrub that is very xeric with persistent gaps and longer fire-return intervals than other types of scrub (pg. 11)	The proposed dicamba DGA uses are not expected to overlap with scrub habitats.	US FWS. 2010. Snakeroot (<i>Eryngium cuneifolium</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3248.pdf
Telephus spurge <i>(Euphorbia telephioides)</i>	Xeric to mesic pine flatwoods and in scrubby pinewoods. Occasionally found in wetlands with seepage slope species and in small clumps of wiregrass surrounded by cyprus or pine.	The proposed dicamba DGA uses are not expected to overlap with woods or wetlands.	US. FWS. 2008. Euphorbia telephioides (<i>Telephus spurge</i>) 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1884.pdf
Tiny polygala <i>(Polygala smallii)</i>	Occurs in four distinct habitats with similar characteristics: pine rockland, scrub, high pine, and open coastal spoil which are pyrogenic-extremely dry and prone to periodic natural fire.	The proposed dicamba DGA uses are not expected to overlap with pine rockland, scrub, high pine, and open coastal spoil.	US FWS. 1999. Multi-Species Recovery Plan for South Florida http://ecos.fws.gov/docs/recovery_plan/sfl_msrp/SFL_MSRP_Species.pdf
White birds-in-a-nest <i>(Macbridea alba)</i>	In general, plants are found in mesic pine flatwoods, wet savannas, seepage slopes, and ecotones between pine flatwoods and titi-swamps. The wettest sites occupied by	The proposed dicamba DGA salt uses are not expected to overlap with mesic pine flatwoods, wet	US FWS. 2009. <i>Macbridea alba</i> (White birds-in-a-nest) 5-Year Review: Summary and Evaluation

	these plants are grassy seepage bogs on gentle slopes at the edge of forested or shrubby wetlands. White birds-in-a-nest also occurs in drier sites along longleaf pine and runner oaks, as well as along associated roadsides.	savannas and seepage slopes.	http://ecos.fws.gov/docs/five_year_review/doc2371.pdf
Wide-leaf warea <i>(Warea amplexifolia)</i>	Endemic to the high pine (or sandhill) habitat of Lake Wales Ridge in Lake, Polk, Osceola, and Orange County, FL. This habitat has a relatively high diversity of herbaceous ground cover maintained by patchy summer fires sparked by lightning. It grows well in open, sandy patches and does not tolerate shading by dense shrubs or trees.	The proposed dicamba DGA uses are not expected to overlap with pine habitat.	US FWS. 2007. Wide-leaf warea <i>(Warea amplexifolia)</i> 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc1096.pdf
Wireweed <i>(Polygonella basiramia)</i>	It occurs in scrub dominated by Florida rosemary, sand pine, other pines, and oaks. The plant occurs in openings in the scrub which are maintained by periodic wildfires. Other plants in this habitat include <i>Calamintha ashei</i> , <i>Cnidoscolus stimulosus</i> , <i>Eryngium cuneifolium</i> , <i>Euphorbia floridana</i> , <i>Hypericum cumulicola</i> , <i>Lechea cernua</i> , <i>Licania michauxii</i> , <i>Paronychia chartacea</i> , <i>Polanisia tenuifolia</i> , <i>Polygonella polygama</i> , <i>Selagniella arenicola</i> , and <i>Stipulicida setacea</i>	The proposed dicamba DGA uses are not expected to overlap with scrub habitat.	US FWS. 2010. Wireweed <i>(Polygonella basiramia)</i> 5-Year Review: Summary and Evaluation http://ecos.fws.gov/docs/five_year_review/doc3280.pdf

Appendix 3

Critical Habitat Designations and PCE Descriptions

Summary of 14 Listed Species Identified as being on Agricultural Fields with and without Critical Habitat Designations for the 11 States (AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA, WV) Assessed for Dicamba DGA salt

Species Name	Primary Constituent Elements (PCE)	Source
<i>Species with Critical Habitat Designations (6 Species)</i> ³		
California condor (<i>Gymnogyps californianus</i>)	PCEs: The following areas of land, water and airspace with spatial bounds described in the critical habitat source documentation: Sespe-Piru Condor Area, Matillija Condor Area, Sisquoc-San Rafael Condor Area, Mountain-Beartrap Condor Area, Mt. Pinos Condor Area, Blue Ridge Condor Area, Tejon Ranch, Kern County rangelands and Tulare County rangelands.	http://ecos.fws.gov/docs/federal_register/fr161.pdf
Gray wolf (<i>Canis lupis</i>)	PCE: Not specified.	http://ecos.fws.gov/docs/federal_register/fr186.pdf
Indiana bat (<i>Myotis sodalis</i>)	Critical habitat designations are either mines or caves.	http://ecos.fws.gov/docs/federal_register/fr161.pdf
Jaguar (<i>Panthera onca</i>)	PCEs: Expansive open spaces in the southwestern United States of at least 100 km ² (38.6 mi ²) in size which: (1) Provide connectivity to Mexico; (2) Contain adequate levels of native prey species, including deer and javelina, as well as medium-sized prey such as coatis, skunks, raccoons, or jackrabbits; (3) Include surface water sources available within 20 km (12.4 mi) of each other; (4) Contain from greater than 1 to 50 percent canopy cover within Madrean evergreen woodland, generally recognized by a mixture of oak (<i>Quercus</i> spp.), juniper (<i>Juniperus</i> spp.), and pine (<i>Pinus</i> spp.) trees on the landscape, or semidesert grassland vegetation communities, usually characterized by <i>Pleuraphis mutica</i> (tobosagrass) or <i>Bouteloua eriopoda</i> (black grama) along with other grasses; (5) Are characterized by intermediately, moderately, or highly rugged terrain; (6) Are below 2,000 m (6,562 feet) in elevation; and (7) Are characterized by minimal to no human population density, no major roads, or no stable nighttime lighting over any 1-km ² (0.4-mi ²) area.	http://www.gpo.gov/fdsys/pkg/FR-2014-03-05/pdf/2014-03485.pdf
Virginia big-eared bat (<i>Corynorhinus</i> (=Plecotus) townsendii virginianus)	Critical habitat designations are caves.	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A080#crithab http://ecos.fws.gov/docs/federal_register/fr366.pdf
Whooping crane (<i>Grus americana</i>)	PCE: All areas proposed in this rule would provide food, water, and other nutritional or physiological needs of the	http://ecos.fws.gov/docs/federal_register/fr237.pdf

³ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

	whooping crane during spring or fall migration. Consumption of some cereal crops in adjacent croplands during migration period. Direct relatable resources to agricultural field possibly treated with 2,4-D choline.	
<i>Species without critical habitat designations (8 species)</i>		
Audubon crested caracara (<i>Polyborus plancus audubonii</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B06Q
Delmarva Peninsula fox squirrel (<i>Sciurus niger cinereus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00B
Eastern indigo snake (<i>Drymarchon corais couperi</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C026#crithab
Florida panther (<i>Puma</i> (= <i>Felis</i>) <i>concolor coryi</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A008
Lesser prairie-chicken (<i>Tympanuchus pallidicinctus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0AZ#crithab
Ocelot (<i>Leopardus</i> (<i>Felis</i>) <i>pardalis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A084#crithab
Red wolf (<i>Canis rufus</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A00F#crithab
Sonoran pronghorn (<i>Antilocapra americana sonoriensis</i>)	None	http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A009

Summary of Listed Species Identified as being off Agricultural Fields without Critical Habitat⁴ (191 species)

Alamosa springsnail (<i>Tryonia alamosae</i>)
American chaffseed (<i>Schwalbea americana</i>)
American hart's-tongue fern (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)
Anastasia Island beach mouse (<i>Peromyscus polionotus phasma</i>)
Apache trout (<i>Oncorhynchus apache</i>)
Apalachicola rosemary (<i>Conradina glabra</i>)
Appalachian Monkeyface, Appalachian (pearly mussel) (<i>Quadrula sparsa</i>)
Arizona Cliff-rose (<i>Purshia</i> (= <i>Cowania</i>) <i>subintegra</i>)
Arizona hedgehog cactus (<i>Echinocereus triglochidiatus</i> var. <i>arizonicus</i>)
Atlantic salt marsh snake (<i>Nerodia clarkii taeniata</i>)
Avon Park harebells (<i>Crotalaria avonensis</i>)
Bachman's warbler (= wood) (<i>Vermivora bachmanii</i>)
Beach jacquemontii (<i>Jacquemontia reclinata</i>)
Beautiful pawpaw (<i>Deeringothamnus pulchellus</i>)
Birdwing pearly mussel (<i>Lemiox rimosus</i>)
Black-footed ferret (<i>Mustela nigripes</i>)
Blackside dace (<i>Phoxinus cumberlandensis</i>)
Bluetail mole skink (<i>Eumeces egregius lividus</i>)
Bog (= Muhlenberg) turtle (<i>Clemmys muhlenbergii</i>)
Brady pincushion cactus (<i>Pediocactus bradyi</i>)
Britton's beargrass (<i>Nolina brittoniana</i>)
Brooksville bellflower (<i>Campanula robinsiae</i>)
California least tern (<i>Sterna antillarum browni</i>)
Canada lynx (<i>Lynx canadensis</i>)
Canby's dropwort (<i>Oxypolis canbyi</i>)
Canelo Hills ladies'-tresses (<i>Spiranthes delitescens</i>)
Carolina northern flying squirrel (<i>Glaucomys sabrinus coloratus</i>)
Carter's mustard (<i>Warea carteri</i>)
Chapman rhododendron (<i>Rhododendron chapmanii</i>)
Cheat Mountain salamander (<i>Plethodon nettingi</i>)
Chittenango ovate amber snail (<i>Succinea chittenangoensis</i>)
Clubshell (<i>Pleurobema clava</i>)
Cochise pincushion cactus (<i>Coryphantha robbinsorum</i>)
Colorado hookless cactus (<i>Sclerocactus glaucus</i>)
Cooley's meadowrue (<i>Thalictrum cooleyi</i>)
Cooley's water-willow (<i>Justicia cooleyi</i>)
Cracking pearly mussel (<i>Hemistena lata</i>)
Crenulate lead-plant (<i>Amorpha crenulata</i>)
Cumberland bean (pearly mussel) (<i>Villosa trabalis</i>)
Cumberland monkeyface (pearly mussel) (<i>Quadrula intermedia</i>)
Deltoid spurge (<i>Chamaesyce deltoidea</i> ssp. <i>deltoidea</i>)
Dromedary pearly mussel (<i>Dromus dromas</i>)
Dudley Bluffs bladderpod (<i>Lesquerella congesta</i>)
Dudley Bluffs twinpod (<i>Physaria obcordata</i>)
Duskytail darter (<i>Etheostoma percnurum</i>)
Dwarf wedgemussel (<i>Alasmidonta heterodon</i>)
Eastern prairie fringed orchid (<i>Platanthera leucophaea</i>)

⁴ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Etonia rosemary (<i>Conradina etonia</i>)
Fanshell (<i>Cyprogenia stegaria</i>)
Finback whale (<i>Balaenoptera physalus</i>)
Finerayed pigtoe (<i>Fusconaia cuneolus</i>)
Flat-spired three-toothed snail (<i>Triodopsis platysayoides</i>)
Florida bonamia (<i>Bonamia grandiflora</i>)
Florida Bonneted bat (<i>Eumops floridanus</i>)
Florida golden aster (<i>Chrysopsis floridana</i>)
Florida grasshopper sparrow (<i>Ammodramus savannarum floridanus</i>)
Florida perforate cladonia (<i>Cladonia perforata</i>)
Florida salt marsh vole (<i>Microtus pennsylvanicus dukecampbelli</i>)
Florida scrub-jay (<i>Aphelocoma coerulescens</i>)
Florida skullcap (<i>Scutellaria floridana</i>)
Florida torreyia (<i>Torreya taxifolia</i>)
Florida ziziphus (<i>Ziziphus celata</i>)
Four-petal pawpaw (<i>Asimina tetramera</i>)
Fragrant prickly-apple (<i>Cereus eriophorus</i> var. <i>fragrans</i>)
Fringed campion (<i>Silene polypetala</i>)
Garber's spurge (<i>Chamaesyce garberi</i>)
Garrett's mint (<i>Dicerandra christmanii</i>)
Gentian pinkroot (<i>Spigelia gentianoides</i>)
Gila topminnow (incl. Yaqui)(<i>Poeciliopsis occidentalis</i>)
Gila trout (<i>Oncorhynchus gilae</i>)
Godfrey's butterwort (<i>Pinguicula ionantha</i>)
Gray bat (<i>Myotis grisescens</i>)
Green blossom (pearly mussel)(<i>Epioblasma torulosa gubernaculum</i>)
Greenback Cutthroat trout (<i>Oncorhynchus clarki stomias</i>)
Harperella (<i>Ptilimnium nodosum</i>)
Harper's beauty (<i>Harperocallis flava</i>)
Hay's Spring amphipod (<i>Stygobromus hayi</i>)
Highlands scrub hypericum (<i>Hypericum cumulicola</i>)
Holy Ghost ipomopsis (<i>Ipomopsis sancti-spiritus</i>)
Houghton's goldenrod (<i>Solidago houghtonii</i>)
Hualapai Mexican vole (<i>Microtus mexicanus hualpaiensis</i>)
Humpback whale (<i>Megaptera novaeangliae</i>)
James spiny mussel (<i>Pleurobema collina</i>)
Jones cycladenia (<i>Cycladenia humilis</i> var. <i>jonesii</i>)
Kearney's blue-star (<i>Amsonia kearneyana</i>)
Kemp's ridley sea turtle (<i>Lepidochelys kempii</i>)
Key deer (<i>Odocoileus virginianus clavium</i>)
Key tree cactus (<i>Pilosocereus robinii</i>)
Kirtland's warbler (<i>Setophaga kirtlandii</i>)
Knieskern's beaked-rush (<i>Rhynchospora knieskernii</i>)
Knowlton's cactus (<i>Pediocactus knowltonii</i>)
Kuenzler hedgehog cactus (<i>Echinocereus fendleri</i> var. <i>kuenzleri</i>)
Lakela's mint (<i>Dicerandra immaculata</i>)
Least tern (<i>Sterna antillarum</i>)
Lee County cave isopod (<i>Lirceus usdagalun</i>)
Leedy's Roseroot (<i>Rhodiola integrifolia</i> ssp. <i>leedyi</i>)
Lee pincushion cactus (<i>Coryphantha sneedii</i> var. <i>leei</i>)
Lewton's polygala (<i>Polygala lewtonii</i>)
Littlewing pearly mussel (<i>Pegias fabula</i>)
Longspurred mint (<i>Dicerandra cornutissima</i>)

Lower Keys marsh rabbit (<i>Sylvilagus palustris hefneri</i>)
Madison Cave isopod (<i>Antrolana lira</i>)
Mancos milk-vetch (<i>Astragalus humillimus</i>)
Masked bobwhite (quail) (<i>Colinus virginianus ridgwayi</i>)
Mesa Verde cactus (<i>Sclerocactus mesae-verdae</i>)
Miami Blue Butterfly (<i>Cyclargus</i> (= <i>Hemiargus</i>) <i>thomasi bethunebakeri</i>)
Miccosukee gooseberry (<i>Ribes echinellum</i>)
Michaux's sumac (<i>Rhus michauxii</i>)
Mitchell's satyr butterfly (<i>Neonympha mitchellii mitchellii</i>)
Nichol's Turk's head cactus (<i>Echinocactus horizonthalonius</i> var. <i>nicholii</i>)
North Park phacelia (<i>Phacelia formosula</i>)
Northeastern beach tiger beetle (<i>Cicindela dorsalis dorsalis</i>)
Northeastern bulrush (<i>Scirpus ancistrochaetus</i>)
Northern monkshood (<i>Aconitum noveboracense</i>)
Northern riffleshell (<i>Epioblasma torulosa rangiana</i>)
Okaloosa darter (<i>Etheostoma okaloosae</i>)
Okeechobee gourd (<i>Cucurbita okeechobeensis</i> ssp. <i>okeechobeensis</i>)
Osterhout milkvetch (<i>Astragalus osterhoutii</i>)
Papery whitlow-wort (<i>Paronychia chartacea</i>)
Pecos gambusia (<i>Gambusia nobilis</i>)
Peebles Navajo cactus (<i>Pediocactus peeblesianus</i> var. <i>peeblesianus</i>)
Penland alpine fen mustard (<i>Eutrema penlandii</i>)
Penland beardtongue (<i>Penstemon penlandii</i>)
Peter's mountain mallow (<i>Iliamna corei</i>)
Pigeon wings (<i>Clitoria fragrans</i>)
Pima pineapple cactus (<i>Coryphantha scheeri</i> var. <i>robustispina</i>)
Pink mucket (pearly mussel) (<i>Lampsilis abrupta</i>)
Puritan tiger beetle (<i>Cicindela puritana</i>)
Pygmy fringe-tree (<i>Chionanthus pygmaeus</i>)
Rayed bean (<i>Villosa fabalis</i>)
Red-cockaded woodpecker (<i>Picoides borealis</i>)
Roan Mountain bluet (<i>Hedyotis purpurea</i> var. <i>montana</i>)
Roanoke logperch (<i>Percina rex</i>)
Rock gnome lichen (<i>Gymnoderma lineare</i>)
Roseate tern (<i>Sterna dougallii dougallii</i>)
Rough pigtoe (<i>Pleurobema plenum</i>)
Rugel's pawpaw (<i>Deeringothamnus rugelii</i>)
Running buffalo clover (<i>Trifolium stoloniferum</i>)
Sacramento prickly poppy (<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i>)
Sand skink (<i>Neoseps reynoldsi</i>)
Sandlace (<i>Polygonella myriophylla</i>)
Sandplain gerardii (<i>Agalinis acuta</i>)
Schaus swallowtail butterfly (<i>Heraclides aristodemus ponceanus</i>)
Scrub blazingstar (<i>Liatris ohlingerae</i>)
Scrub buckwheat (<i>Eriogonum longifolium</i> var. <i>gnaphalifolium</i>)
Scrub lupine (<i>Lupinus aridorum</i>)
Scrub mint (<i>Dicerandra frutescens</i>)
Scrub plum (<i>Prunus geniculata</i>)
Seabeach amaranth (<i>Amaranthus pumilus</i>)
Sensitive joint-vetch (<i>Aeschynomene virginica</i>)
Sentry milk-vetch (<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>)
Shale barren rock cress (<i>Arabis serotina</i>)
Sheepnose mussel (<i>Plethobasus cyphus</i>)

Shenandoah salamander (<i>Plethodon shenandoah</i>)
Shiny pigtoe (<i>Fusconaia cor</i>)
Short-leaved rosemary (<i>Conradina brevifolia</i>)
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)
Siler pincushion cactus (<i>Pediocactus</i> (= <i>Echinocactus</i> , = <i>Utahia</i>) <i>sileri</i>)
Small whorled pogonia (<i>Isotria medeoloides</i>)
Small-anthered bittercress (<i>Cardamine micranthera</i>)
Small's milkpea (<i>Galactia smallii</i>)
Smalltooth sawfish (<i>Pristis pectinata</i>)
Smooth coneflower (<i>Echinacea laevigata</i>)
Snakeroot (<i>Eryngium cuneifolium</i>)
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)
Snuffbox mussel (<i>Epioblasma triquetra</i>)
Socorro isopod (<i>Thermosphaeroma thermophilus</i>)
Socorro springsnail (<i>Pyrgulopsis neomexicana</i>)
Sonora tiger Salamander (<i>Ambystoma tigrinum stebbinsi</i>)
Southeastern beach mouse (<i>Peromyscus polionotus niveiventris</i>)
Southern sandshell (<i>Hamiota</i> (= <i>Lampsilis</i>) <i>australis</i>)
Spectaclecase (mussel) (<i>Cumberlandia monodonta</i>)
Squirrel Chimney Cave shrimp (<i>Palaemonetes cumingii</i>)
Stock Island tree snail (<i>Orthalicus reses</i>)
Swamp pink (<i>Helonias bullata</i>)
Tan Riffleshell (<i>Epioblasma florentina walkeri</i> (= <i>E. walkeri</i>))
Telephus spurge (<i>Euphorbia telephioides</i>)
Tiny polygala (<i>Polygala smallii</i>)
Tubercled blossom (pearly mussel) (<i>Epioblasma torulosa torulosa</i>)
Uncompahgre fritillary butterfly (<i>Boloria acrocneuma</i>)
Ute Ladies'-Tresses, (<i>Spiranthes diluvialis</i>)
Virginia fringed mountain snail (<i>Polygyriscus virginianus</i>)
Virginia round-leaf birch (<i>Betula uber</i>)
Virginia sneezeweed (<i>Helenium virginicum</i>)
Virginia spiraea (<i>Spiraea virginiana</i>)
White birds-in-a-nest (<i>Macbridea alba</i>)
Wide-leaf warea (<i>Warea amplexifolia</i>)
Wireweed (<i>Polygonella basiramia</i>)
Wood stork (<i>Mycteria americana</i>)
Yuma clapper rail (<i>Rallus longirostris yumanensis</i>)
Zuni fleabane (<i>Erigeron rhizomatus</i>)

Summary of Listed Species Identified as being off Agricultural Fields with Critical Habitat⁵ (117 species)

Aboriginal prickly-apple (<i>Harrisia aboriginum</i>)
Acuna Cactus (<i>Echinomastus erectocentrus</i> var. <i>acunensis</i>)
American crocodile (<i>Crocodylus acutus</i>)
Arkansas River shiner (<i>Notropis girardi</i>)
Bartram's Hairstreak Butterfly (<i>Strymon acis bartrami</i>)
Beautiful shiner (<i>Cyprinella formosa</i>)
Bonytail chub (<i>Gila elegans</i>)

⁵ Critical habitat designation status determined using U.S. Fish & Wildlife Service's Environmental Conservation Online System (ECOS) species profiles.

Cape Sable seaside sparrow (<i>Ammodramus maritimus mirabilis</i>)
Cape Sable thoroughwort (<i>Chromolaena frustrata</i>)
Carter's small-flowered flax (<i>Linum carteri carteri</i>)—(proposed)
Chihuahua chub (<i>Gila nigrescens</i>)
Chipola slabshell (<i>Elliptio chipolaensis</i>)
Chiricahua leopard frog (<i>Rana</i> (= <i>Lithobates</i>) <i>chiricahuensis</i>)
Choctaw bean (<i>Villosa choctawensis</i>)
Choctawhatchee beach mouse (<i>Peromyscus polionotus alloparys</i>)
Chupadera springsnail (<i>Pyrgulopsis chupaderae</i>)
Clay-loving wild buckwheat (<i>Eriogonum pelinophilum</i>)
Colorado Butterfly Plant (<i>Gaura neomexicana</i> var. <i>coloradensis</i>)
Colorado pikeminnow (=squawfish)(<i>Ptychocheilus lucius</i>)
Cumberlandian combshell (<i>Epioblasma brevidens</i>)
DeBeque phacelia (<i>Phacelia submutica</i>)
Desert tortoise (<i>Gopherus agassizii</i>)
Desert pupfish (<i>Cyprinodon macularius</i>)
Diamond darter (<i>Crystallaria cincotta</i>)
Elkhorn coral (<i>Acropora palmate</i>)
Everglade snail kite (<i>Rostrhamus sociabilis plumbeus</i>)
Fat three-ridge (mussel) (<i>Amblema neislerii</i>)
Fickeisen Plains cactus (<i>Pediocactus peeblesianus fickeiseniae</i>)
Florida brickell-bush (<i>Brickellia mosieri</i>)—(Proposed)
Florida Leafwing Butterfly (<i>Anaea troglodyta floridalis</i>)
Florida semaphore cactus (<i>Consolea corallicola</i>)
Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)
Frosted flatwoods salamander (<i>Ambystoma cingulatum</i>)
Fuzzy pigtoe (<i>Pleurobema strodeanum</i>)
Gierisch mallow (<i>Sphaeralcea gierischii</i>)
Gila chub (<i>Gila intermedia</i>)
Green sea turtle (<i>Chelonia mydas</i>)
Gulf moccasinshell (<i>Medionidus penicillatus</i>)
Gulf sturgeon (<i>Acipenser oxyrinchus desotoi</i>)
Gypsum wild-buckwheat (<i>Eriogonum gypsophilum</i>)
Hawksbill sea turtle (<i>Eretmochelys imbricata</i>)
Holmgren milk-vetch (<i>Astragalus holmgreniorum</i>)
Huachuca water-umbel (<i>Lilaeopsis schaffneriana</i> var. <i>recurva</i>)
Humpback chub (<i>Gila cypha</i>)
Jemez Mountains salamander (<i>Plethodon neomexicanus</i>)
Johnson's seagrass (<i>Halophila johnsonii</i>)
Kanab ambersnail (<i>Oxyloma haydeni kanabensis</i>)—(proposed)
Karner blue butterfly (<i>Lycaeides melissa samuelis</i>)
Key Largo cotton mouse (<i>Peromyscus gossypinus allapaticola</i>)—(proposed)
Key Largo woodrat (<i>Neotoma floridana smalli</i>)
Koster's springsnail (<i>Juturnia kosteri</i>)
Leatherback sea turtle (<i>Dermochelys coriacea</i>)
Lesser long-nosed bat (<i>Leptonycteris curasoae yerbabuenae</i>)
Little Colorado spinedace (<i>Lepidomeda vittata</i>)
Loach minnow (<i>Tiaroga cobitis</i>)
Loggerhead sea turtle (<i>Caretta caretta</i>)
Maryland darter (<i>Etheostoma sellare</i>)
Mexican long-nosed bat (<i>Leptonycteris nivalis</i>)
Mexican spotted owl (<i>Strix occidentalis lucida</i>)
Mount Graham red squirrel (<i>Tamiasciurus hudsonicus grahamensis</i>)

Narrow pigtoe (<i>Fusconaia escambia</i>)
Narrow-headed gartersnake (<i>Thamnophis rufipunctatus</i>)—(Proposed)
Navajo sedge (<i>Carex specuicola</i>)
New Mexican ridge-nosed rattlesnake (<i>Crotalus willardi obscurus</i>)
New Mexico meadow jumping mouse (<i>Zapus hudsonius luteus</i>)—(Proposed)
Noel's amphipod (<i>Gammarus desperatus</i>)
North Atlantic right whale (<i>Eubalaena glacialis</i>)
Northern Mexican gartersnake (<i>Thamnophis eques megalops</i>)—(Proposed)
Ochlockonee moccasinshell (<i>Medionidus simpsonianus</i>)
Oval pigtoe (<i>Pleurobema pyriforme pyriforme</i>)
Ovate clubshell (<i>Pleurobema perovatum</i>)
Oyster mussel (<i>Epioblasma capsaeformis</i>)
Pagosa skyrocket (<i>Ipomopsis polyantha</i>)
Parachute beardtongue (<i>Penstemon debilis</i>)
Pawnee montane skipper (<i>Hesperia leonardus montana</i>)
Pecos (=puzzle, =paradox) sunflower (<i>Helianthus paradoxus</i>)
Pecos assiminea snail (<i>Assiminea pecos</i>)
Pecos bluntnose shiner (<i>Notropis simus pecosensis</i>)
Perdido Key beach mouse (<i>Peromyscus polionotus trissyllepsis</i>)
Piping plover (<i>Charadrius melodus</i>)
Preble's meadow jumping mouse (<i>Zapus hudsonius preblei</i>)
Purple bankclimber (mussel) (<i>Elliptoideus sloatianus</i>)
Bean, Purple (<i>Villosa perpurpurea</i>)
Rabbitsfoot (<i>Quadrula cylindrica cylindrica</i>)
Razorback sucker (<i>Xyrauchen texanus</i>)
Reticulated flatwoods salamander (<i>Ambystoma bishopi</i>)
Rice rat (<i>Oryzomys palustris natator</i>)
Rio Grande silvery minnow (<i>Hybognathus amarus</i>)
Roswell springsnail (<i>Pyrgulopsis roswellensis</i>)
Rough rabbitsfoot (<i>Quadrula cylindrica strigillata</i>)
Round ebonyshell (<i>Fusconaia rotulata</i>)
Sacramento Mountains thistle (<i>Cirsium vinaceum</i>)
San Bernardino springsnail (<i>Pyrgulopsis bernardina</i>)
San Francisco Peaks ragwort (<i>Packera franciscana</i>)
Shinyrayed pocketbook (<i>Lampsilis subangulata</i>)
Slabside pearlymussel (<i>Pleuronaia dolabelloides</i>)
Slender chub (<i>Erimystax cahni</i>)
Smalleye shiner (<i>Notropis buccula</i>)
Sonora chub (<i>Gila ditaenia</i>)
Southern kidneyshell (<i>Ptychobranthus jonesi</i>)
Southwestern willow flycatcher (<i>Empidonax traillii extimus</i>)
Spikedace (<i>Meda fulgida</i>)
Spotfin chub (<i>Erimonax monachus</i>)
Spruce-fir moss spider (<i>Microhexura montivaga</i>)
St. Andrew beach mouse (<i>Peromyscus polionotus peninsularis</i>)
Staghorn coral (<i>Acropora cervicornis</i>)
Tapered pigtoe (<i>Fusconaia burkei</i>)
Three Forks Springsnail (<i>Pyrgulopsis trivialis</i>)
Todsens pennyroyal (<i>Hedeoma todsenii</i>)
Virgin River Chub (<i>Gila seminuda</i> (=robusta))
West Indian manatee (<i>Trichechus manatus latirostris</i>)
Welsh's milkweed (<i>Asclepias welshii</i>)
Woundfin (<i>Plagopterus argentissimus</i>)

Yaqui catfish (<i>Ictalurus pricei</i>)
Yaqui chub (<i>Gila purpurea</i>)
Yellowfin Madtom (<i>Noturus flavipinnis</i>)
Zuni bluehead sucker (<i>Catostomus discobolus yarrowi</i>)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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May 20, 2014

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the
Section 3 New Use of on Dicamba-Tolerant Soybean

TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist *Elizabeth Donovan*
Reuben Baris, Environmental Scientist *Reuben Baris*
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

THRU: Mark Corbin, Branch Chief *Mark Corbin*
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

REVIEWED Charles Peck, Physical Scientist *Charles Peck*

BY: Faruque Khan, Ph.D., Physical Scientist *Faruque Khan*
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC₀₅ (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft.* Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*; MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC_{25} and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as "an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height", were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (Table 4). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (Table 5). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th%-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th%-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th%-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{‡‡}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{Kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{‡‡} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{Kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate,...etc

concentration from AERSCREEN at the edge of the field is 283 ug/m^3 less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of $0.0004 \text{ ug/m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 ug/m^3 however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD.
							Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and In-In transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile*
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave. (coarse)	124.08	124.08		DSD ≥ VC
			Ave. (xc)	107.71	107.71		DSD ≥ XC

*Note: no difference in In-In vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean

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This is an addendum to the Environmental Fate and Effects Division's (EFED) ecological risk assessment for dicamba DGA salt (Clarity[®] formulation or M169I, EPA Reg No. 524-582) and its degradate, 3,6-dichlorosalicylic acid (DCSA), for the proposed new use on dicamba-tolerant soybean. It includes analysis of information that was not previously included in the original soybean new use risk assessment (USEPA, 2011, DP 378444). Since the original risk assessment was conducted, the registrant, Monsanto, has submitted:

- 1) field trial data that impacts EFED's previous analysis of spray drift,
- 2) data for incidents and inquiries from the use of dicamba DGA salt,

- 3) laboratory volatility data for dicamba DGA and DMA salt formulations, and
- 4) terrestrial plant reproductive effects data.

Additionally, this addendum includes analysis conducted by EFED regarding:

- 5) the implication of new mammalian chronic effects endpoints for parent dicamba and the metabolite DCSA from the Health Effects Division (HED; USEPA 2016, D378366+),
- 6) a revised T-REX run using refined estimates of foliar dissipation half-lives and variable application rates,
- 7) the potential for effects to beneficial terrestrial invertebrates,
- 8) effects posed by runoff, and
- 9) potential synergistic interactions with glyphosate.

1. Spray Drift and Buffers (Field Trial Data)

In the first addendum to the EFED Section 3 risk assessment for dicamba DGA salt for use on dicamba-tolerant soybeans (D404138, 5/20/14), EFED estimated that the distance from the application site to where no effects are observed to sensitive plants (based on the NOAEC for the most sensitive apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) ranged from 100 to 175 feet (for the 0.5 lb a.e./A tolerant-soybean post-emergent application rate). However, based on a weight of evidence approach and refined AgDrift modeling for coarser droplet spectra (coarse to ultra-coarse droplet distribution), EFED refined this distance to 124 feet (rounded up to 125 feet) or to 107 feet if label language were to restrict the droplet size to solely extra-coarse and ultra-coarse droplet sizes).

EFED further refined this analysis after receiving more information including a spray drift deposition study submitted by BASF (MRID 49067704). In light of this information, Monsanto proposed that the spray drift buffer distance be reduced to 70 feet for M1691 Herbicide using the TTI 11004 nozzle at application spray pressures ≤ 63 psi. EFED's subsequent analysis for submitted field trial data (presented below), however, indicates that a larger buffer may be necessary in order to limit potential effects to sensitive plants to the sprayed field. **Linking this data to our previous modeling efforts and employing a weight of evidence approach, EFED proposes that the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Field Trial Data Discussion

Subsequent to EPA's 5/20/2014 addendum, Monsanto presented information from academic field research that had not previously been submitted to the Agency for review. EPA requested data from these field trials and Monsanto submitted the raw data (MRID 49612701 pg. 51) on 4/13/2015 along with a response document (MRID 49570501 pg. 1). Monsanto's response document included an analysis that the 70 foot buffer would be protective of the no-effect

distance for sensitive plants (the “no-effect” distance is based on the most sensitive NOAEC for the apical endpoint of plant height for the most sensitive tested species, non-dicamba tolerant soybeans) for 7 of the 9 submitted trials and a proposed rationale for why it may not have been protective in the remaining 2 trials. The response document also included Monsanto’s statement that the field trial data are not suitable for use in EPA’s regulatory decision-making process, but overall support the then-proposed 70 foot buffer.

While EFED agrees that the field trial data are generally not suitable for regulatory decision-making, we believe that they demonstrate additional uncertainty that the previously proposed 70 foot buffer would be sufficient to prevent potential effects to non-target plants that are off the field. In an attempt to conduct a quantitative evaluation of the field trial data, EFED considered that the data could reasonably represent a dose-response effect, with higher treatment doses expected to be closer to the application site. In this context, the distances farthest from the application site were considered to be likely to have little to no dicamba residues and loosely were considered controls. EFED then considered that plant heights and yield (similar to our apical endpoints of plant height and biomass from the standard vegetative vigor plant ecotoxicity tests) at the closer distances (*i.e.* treatment groups) could be compared to those of plants at the “control” distances using statistical hypothesis tests, similar to our standard statistical methodologies for data evaluation of ecotoxicity tests. In an effort to streamline the data analysis process, EFED used standard t-tests in Excel to conduct the analysis.

This statistical analysis indicated that a majority (5/9) of the field trials provided evidence that the proposed 70 foot buffer would not be sufficient to keep any effects to sensitive plants’ apical endpoints contained to the field. Three of the nine trial sites had significant inhibitions compared to the “control groups” at distances greater than EFED’s refined buffer of 125 feet, though EFED notes Monsanto’s rationale for the greater distances in two of those sites (Monmouth, IL and Haubstadt, IN) might be due to applications not conforming to the currently proposed label restrictions for M-1691 Herbicide. The maximum “no effect” spray drift distance that EFED determined for the remaining site (Rower, AR) was 147.5 feet.

Since these field trials involved no true controls and residue analysis was not conducted to confirm the lack of residues in the farthest plants, the magnitude of an effect seen between “treatment” groups and true control plants might be higher than what this analysis indicates. These field trials were all conducted at the 0.5 lbs a.e./A (maximum single post-emergent application rate) and all were conducted using the TTI11004 nozzle in accordance with the label directions. The operating pressures varied across the sites from 30 psi to 50 psi (other than for the Haubstadt trial site, for which nozzle pressures were not recorded), which is less than the labeled maximum operating pressure of 63 psi. Higher operating pressures than used in these field trials (but within the proposed labeled directions for use), may result in an increased proportion of finer spray droplets and consequently result in effects at distances greater than observed in these field trials. The specific process, results and conclusions that EFED used in evaluating Monsanto’s submitted field trial data and relating it as an additional line of evidence in determining an appropriate buffer that would result in no adverse effects to EPA’s apical

endpoints for terrestrial plants (the most sensitive taxa to the herbicide dicamba), is discussed immediately below.

Details of EFED's Process to Determine a "No Effect" Spray Drift Buffer from the Available Field Trial (MRID 49612701 pg. 51) Data:

Transects (at each site or for each swath, where multiple swaths were tested) were combined to determine mean soybean (non dicamba-tolerant) plant heights (14 & 28 DAT) or yields at set distances. The farthest two distances for which plant height or yield data were recorded were considered "controls," though there are considerable uncertainties to this approach. Specifically, no true controls were used, no residue analysis was conducted to confirm that these plants were not exposed to dicamba (or other chemical) residues, data were only recorded when there was at least 5% visual response (which could have been due to a number of factors including potential dicamba residues) and for many of these "controls" the height/yield endpoint may not have been recorded in all transects, resulting in a lower sample size (n) for controls and therefore a decreased power in the statistical t-test.

All analyses were conducted in MS Excel. Means for each distance towards the sprayer were compared to the "control" means to determine the percent inhibition at each distance. T-tests (1-tailed, assumed equal variances unless an F-test { $p < 0.05$ } showed unequal variances) were conducted to compare the endpoints of the treatment distances to the controls. Since these were field tests and had considerable uncertainties surrounding the controls, EFED considered significance at the ($\alpha =$) 0.1 level which increases the conservatism of the analysis. The buffer for a "no effect" distance at each site was considered the first distance greater than the maximum distance which had a significant decrease compared to the control group. For example, at the Brooksville, MS site, the furthest distance which exhibited a significant decrease ($p < 0.10$) in height at 28 DAT compared to the control group was 86.25 feet. The next highest distance at which soybean heights were measured was 96.25 feet (not significant, $p = 0.19$), which therefore was considered the "no effect" distance buffer for that site.

Results of the Analysis of the Field Trial (MRID 49612701) Data

After reviewing this field trial data, EFED made the following findings. Of the nine field trials discussed above, a majority (five) provide evidence that a 70 foot buffer may not be sufficient, and four provide evidence that a 100 foot buffer may not be sufficient (**Table 1**). With a buffer distance of 125 feet for a 0.5 lb a.e./A application rate, 3 sites (33%) would provide evidence that a larger buffer might be necessary, with Monsanto stating (and subsequently providing information) that two of these (Monmouth and Haubstadt) may not have followed the currently proposed label by either using a different formulation or applying when wind speed was lower than required by the current proposed draft label.

Table 1. Distance (in feet) from Site of Application to a "No Effect" *

Site	Height (ft.) 14 DAT	Height (ft.) 28 DAT	Yield (ft.)	Comments
Brooksville, MS	46.25	96.25	66.25	
Rower, AR	7.9	20.6	248.7**	14 DAT "controls" had only n=2. 28 DAT controls had n=3. **Note, for yield, after the 12% inhibition at 223.4', no treatment group was significantly (p<0.1) inhibited compared to controls (inhibitions ranged from 1.03—23.75% after this). The higher inhibitions were not significant due to the use of the nonequal variance t-test, but would have been had we assumed equal variances). Therefore, using best professional judgment informed by the data and t-test results, EFED has reduced the no effect distance for this endpoint to 147.5' , after which all inhibitions at shorter distances were > 10% (other than only 1.1% inhibition at 7.9 feet).
W. Lafayette, IN	66.25	26.25	No Data	14 DAT "controls" had n=3, 28 DAT "controls" had n=2
Scott, MS	26.25	26.25	66.25	
Jackson, TN	16.25	16.25	16.25	Yield "controls" had n=4.
Kirkwood, IL	116.25	116.25	16.25	
Monmouth, IL Swath 1	74.2	137.8	0	14 DAT controls had n=4, 28 DAT controls had n=3, Yield controls had n=3
Monmouth, IL Swath 2	53	95.4	254.4	14 DAT controls had n=3, 28 DAT controls had n=2, Yield controls had n=2
Haubstadt, IN Swath 1	30	80	10	Swath 1 only took measurements to a maximum of 100 feet. 14 DAT controls had n=5, 28 DAT controls had n=3
Haubstadt, IN Swath 2	40	80	150	14 DAT controls had n=3, 28 DAT controls had n=3, Yield controls had n=2
Gilbert, IA Swath 1	N/A	N/A	N/A	This swath was not evaluated as no field measurements were taken past 30 feet.
Gilbert, IA Swath 2	35	15	5	14 & 28 DAT and Yield controls had n=4. For yield, no distance had lower mean yield compared to controls.

* Distance based on Plant Height after 14 and 28 days after treatment (DAT) and Yield ($\alpha = 0.10$). No effect" indicates no reduction in plant height or biomass relative to controls. In controls, the sample size (n) is considered 6 (or 10 for Brooksville, MS and Scott, MS trial sites) unless otherwise noted in the comments section where fewer controls may affect the power of the test.

Weight of Evidence Conclusions

After reviewing the field trial data submitted to EPA, EFED finds that there is considerable uncertainty around the use of a 70 foot in-field buffer with the intent to keep any adverse effects (related to our apical endpoints of plant height and biomass) on the field, as the majority of the sites appeared to have effects on plant height at distances past this. Though the quality of this field trial data is not suitable for the purpose of establishing an appropriate buffer distance (especially as the lack of true controls may mean that the magnitude of effects to true control plants could be greater than indicated here), EFED believes this data provides a line of evidence that an in-field buffer greater than 70 feet is warranted to ensure protection of listed species, such as that determined in our previous risk assessment addendum (D404138, 5/20/14) which used a refined modeling approach extracting out the coarse, extra-coarse and ultra-coarse droplet spectra to determine an average 124 foot buffer (rounded up to 125 feet) or **solely the extra-coarse and ultra-coarse droplet spectra for an estimated average distance of 107 feet (rounded up to 110 feet) for a 0.5 lbs a.e./A application**. The draft label only supports the use of one nozzle (Tee Jet® TTII 1004) with a maximum operating pressure of 63 psi which restricts droplet spectra to ultra-coarse and extremely coarse.

Using a weight of evidence approach (covering the refined modeling analysis conducted in the previous risk assessment addendum, the spray drift deposition study submitted by BASF (MRID 49067704) and the submitted field trial data discussed here), EFED concluded that **the label should be modified to include language to maintain a 100 to 110 foot downwind buffer when applying at the 0.5 lbs a.e./A application rate and with the described nozzles restricting the droplet spectra extra-coarse and ultra-coarse. The July 2015 amended labels subsequently submitted by Monsanto included a 110 foot buffer and 220 foot buffer for 0.5 and 1.0 lbs a.e./A application rates, respectively.**

Further data that may help refine this estimate would be field trial data with actual controls (and/or residue analysis to indicate a lack of dicamba or other herbicide treatments), larger control sample sizes and transect replication, field measurements provided regardless of whether plant visual response (damage) was observed or not, a greater number of swaths at each trial site (reflective of typical practices in soybean agriculture) and using the maximum labeled nozzle operating pressure.

2. Incidents

Incident Reports Submitted by Monsanto (2012-2014)

Monsanto provided information for 73 incidents involving the M1691 formulation from 2012 to 2014. In their response document (MRID 49612701 pg. 68), Monsanto notes that observations were solely qualitative visual estimates and that no measurements of apical endpoints such as plant height or yield were taken. Monsanto further noted that the incidents related either to seed production activities or to activities performed as part of the product development process relating to product stewardship. They stated that current proposed label requirements were not in

place in 2012, that all of these incidents either did not follow all of the current draft label requirements (including tank mixtures with additional pesticide active ingredients such as glyphosate, nozzle type, wind-speed, wind direction, spray volume, etc.) or they were a result of other factors (e.g. burndown application, heavy rainfall, equipment contamination, spillage, etc.) and that the percentage of incidents as a function of the number of applications made has decreased in each subsequent year since 2012.

EFED has conducted an initial review of these incidents and generally agrees with Monsanto that the incidents resulted from applications not in accordance with currently proposed draft label language or were attributed to other (non-dicamba) factors. However, four incidents (Inquiries 19, 20, 24, and 30) from 2014 lacked sufficient information in the report (such as on tank mixture, application rates, nozzles, wind direction & speed, equipment speed, buffer distance, spray volume & pressure or boom height) to determine whether their occurrence followed applications that were in accordance with the current proposed draft label requirements. Although, as Monsanto notes, much of this data arises from seed production activities or activities related to the product development process and were not generated for purposes of risk assessment, EFED does not discount that they could be suggestive of potential incidents in the field and they could provide useful information to that end.

EFED also acknowledges that the incident observations are qualitative measures of visual injury (e.g. leaf spotting or curling). Nonetheless, the information presented in these incidents may be useful if future labels incorporate changes such as potential tank mixes with additional active ingredients or additional nozzle types, since some of these incidents include information on tank mixes and nozzle types which would be relevant in the case where those changes are made to the label.

Missouri and Arkansas Case files

The Missouri Department of Agriculture (MDA) has submitted information for incidents occurring from 2013 to 2015 and the Arkansas Plant Board (APB) has submitted information for incidents occurring in 2015, regarding observations of dicamba-type damage to non-tolerant plants following either preemergence or postemergence applications to dicamba-tolerant (DT) soybeans or cotton. Similar to the incidents reported by Monsanto for 2012-2014, all of the incidents were qualitative visual estimates and no observations or measurements of apical endpoints such as plant height or yield were taken.

2013-2014 Incidents

MDA has notified EPA of two incidents following potential dicamba applications that occurred in 2013 and 2014. In 2013, dicamba-type damage was observed in a non-DT soybean field (MO Case File #81513M00701, EIIIS Incident report number I026579-001). The only dicamba application in the area was reported to be a Clarity herbicide application on DT-soybeans 2,800 feet from the damaged field. The air temperature and humidity at the time of dicamba application were reported to be 82°F and 55%, respectively. Dicamba residues were found in one foliage sample taken from the affected field at 42 µg/kg. In the other two samples, dicamba residues were not detected (limit of detection not reported, but a limit of quantification of 3.8

µg/kg). The case file submitted to the agency did not originally determine the cause of the dicamba damage. In subsequent communication with the Agency (2015 letter from D. Slade, MDA to Grant Rowland, EPA), MDA concluded that the application of Clarity herbicide was not transported to the affected site by spray drift, but by later volatilization.

In their response document (MRID 49612701 pg. 1, submitted prior to MDA's December, 2015 letter), Monsanto noted that it has reviewed the complete incident report from the Missouri Department of Agriculture (MRID 49612701 pg. 75). Monsanto stated that the report indicated that 1) there was potential the crop visual injury response was observed prior to the dicamba application, 2) MO Department of Agriculture did not come to a definitive conclusion on the primary cause of the incident and 3) other plausible explanations were not investigated, such as temperature inversion, alternative sources of dicamba, such as leaking equipment or damage from other herbicides. Therefore, Monsanto concluded that the incident did not provide evidence that the observed plant response was a result of exposure to vapor drift of dicamba residues. Monsanto also included this incident in their description of the 73 incidents from 2012-2014 discussed previously in this section and noted that this incident would not comply with the current proposed label requirements, as M1691 was tank mixed with glyphosate and other adjuvants.

EPA notes that MDA has now completed their investigation of this incident, measured residues indicating the presence of dicamba residues on the affected site, concluded that dicamba volatilization rather than drift was the likely cause of the damage and initiated enforcement action against the applicator for allowing the product to move from the target field. The climatic conditions at the time of application were slightly outside of the range of conditions from the available laboratory studies on dicamba DGA salt's volatility. Given that effects to EPA's apical endpoints of plant height and biomass were not measured, there is uncertainty whether this incident indicates that volatilization following dicamba applications may result in impacts to apical endpoints beyond the proposed spray drift buffer of 110 feet for a 0.5 lb/A application. However, based on the available data, a volatilization buffer equal to the spray drift buffers, and extending in all directions from the treated field, is justified. The current proposed labels only apply a unidirectional spray drift buffer in the direction wind is blowing. Further discussion of volatility is provided in **Section 3** below.

MDA also notified EPA of an incident in 2014 (MO Case File #072214MO0701) where "dicamba type" damage was observed on a non-DT cotton field where the only nearby dicamba application would have been a Clarity herbicide application on DT-soybeans, 2.2 miles from the affected site. As with the other incidents, the provided information only indicated observations of visual injury and not effects to apical endpoints such as plant height and yield. Residue samples taken from the affected site failed to detect dicamba residues. It is unclear whether this incident was also included in Monsanto's submitted information on the 73 incidents from 2012-2014 (discussed previously in this section). With the current information available, and due to the lack of identified dicamba residues, it is uncertain whether the damage observed in the incident was a result of dicamba applications or due to some other unidentified cause. If the observed damage was caused by dicamba, then given the large distance between the affected site and the nearest known dicamba application, it would likely have been a result of volatilization, rather than spray drift.

2015 Incidents

Missouri and Arkansas recently submitted to EPA a total of 15 incidents in 2015 that might be attributed to dicamba use (12 in Arkansas and 3 in Missouri). The information indicates that these incidents resulted from 6 separate instances of applications of dicamba, with 8 of the incidents (7 from Arkansas and 1 from Missouri) being a result of a single instance of a post-emergent dicamba application to DT-cotton of Strut herbicide (active ingredient Dicamba DGA), tank-mixed with glyphosate and applied at two times the labeled rate for the proposed Clarity/M1691 post-emergent use. Visual observations of plant damage extended to 1320 feet (1/4 mile) from the application site. The remaining incidents were pre-emergent applications of dicamba or at this time remain uncertain as to whether any application of dicamba was made.

Conclusions Regarding Incident Information 2012—2015

For the purposes of the registration of dicamba on dicamba-tolerant soybean, the incident information available at this time indicates that the vast majority of incidents occurred following applications that were not made according to the current draft label requirements. Label requirements that were not followed included tank mixes with other active ingredients and adjuvants, higher application rates, and applications with different nozzle types and climatic conditions than permitted according to the draft label. Quantitative measurements of yield loss or decreased plant height were not made in any of the incident descriptions. Currently, EPA has no methodology for relating qualitative estimates of visual damage to quantitative effects to apical endpoints.

Most of these incidents were likely caused by spray drift off the field following the application. The only incident where volatility of dicamba residues has been concluded to be the cause of the incident by a regulatory agency (MDA for MO Case File #81513M00701, EIS Incident report number I026579-001) was an incident where the application was also made as a tank mix of glyphosate, additional adjuvants, and dicamba. However, EFED believes that this difference from the draft label is unlikely to have impacted the ability of dicamba residues to volatilize since the different active ingredients and adjuvants are generally presumed to have disassociated from each other by the time any volatilization would occur. Rather, the volatilization may have been more likely impacted by the climatic conditions (temperature and humidity) in the days following the application which fall outside of the range of submitted laboratory data conditions. Additional discussion and characterization of volatility is provided in the next section.

3. Volatility

After reviewing data submitted to EPA relating to the volatility of dicamba, EFED had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission (MRID 49612701 pg. 143) that acknowledged the long-recognized volatility of dicamba and described measurements of the volatilization in the different formulations.

The information submitted to address EFED's concerns was helpful, but the submission did not include enough detail to verify the measurements in the studies. EFED determined that it would be useful also to perform volatility experiments under varied conditions of temperature and relative humidity, because these factors seem to be important in field conditions.

The registrant has agreed to place directional, in-field spray drift buffers of 110 feet for the 0.5 lb a.e./A application rate and 220 feet for the 1.0 lb a.e./A application rate. One open literature study (Egan and Mortensen 2012), directly addresses the potential for volatilization and transport of dicamba, and the potential for damage to the most sensitive tested species, soybean (non dicamba-tolerant). Based on damage assessments of non dicamba-tolerant soybean plants placed near treated fields after spray drift from a 0.5 lb/A DGA salt application had dissipated, the authors estimated the exposure at distance by correlation to known dose-damage correlations. They estimated that the 95% upper bound vapor exposure would drop below the soybean NOAEC at approximately a distance of 25 meters (82 feet). This is well within the 110-foot spray drift buffer proposed for the 0.5-lb/A rate. Thus, based on at least one study, this buffer distance should be adequate to protect against volatilization exposure for EPA's apical endpoints of plant height and yield. However, consideration should be made as to whether this buffer distance should be applied on all sides of the field, rather than the currently labeled uni-directional buffer according to wind direction.

The incident described by MDA in the previous section (MO Case File #81513M00701, EHS Incident report number I026579-001) provides limited information that the proposed 110 to 220-foot spray drift buffers would not be adequate to limit off-site plant damage due to post-application volatilization. However, since the incident only qualitatively describes visual damage, while the buffer is intended to be protective of apical endpoints of height and yield, this remains an uncertainty, and would benefit from additional field trial data under varied conditions of temperature and relative humidity. Based on the best available data for dicamba residues from vapor drift compared to effects on apical endpoints, EFED believes that a 110 foot buffer for the 0.5 lb ae/A application rate should be adequate to protect against effects on non-target plants from volatilization of dicamba residues. This analysis similarly suggests that a 220-foot buffer is protective for the 1.0 lb ae/A application rate, though this may be overly conservative since the 1.0 lb ae/A rate is for pre-emergent applications that may be applied under conditions less conducive to vapor drift (e.g. cooler temperatures)

4. Potential Effects on Terrestrial Plant Reproduction

EFED is aware of published literature associating dicamba applications with effects to soybean progeny. These studies indicate potential effects to the quantity and reproductive quality of future soybean generations following dicamba applications that would not be observed in the guideline vegetative vigor and seedling emergence studies EFED typically uses to assess risk to terrestrial plants. Therefore, these data raise a potential concern that has not been directly addressed in OPP assessments, should these effects occur at lower exposures than the effects observed in the guideline terrestrial plant studies. In meetings and email correspondence in January/February, 2015, OPP asked whether Monsanto was aware of this issue. Monsanto requested the references that OPP was aware of, so that they could independently review them.

Monsanto reviewed the open literature references provided by OPP and stated that none of the studies described effects on progeny at application rates lower than OPP's lowest available regulatory endpoint from the available vegetative vigor plant study (0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), therefore any mitigations (*i.e.* spray drift buffers) based on the plant height endpoint would be protective for effects to progeny.

The open literature studies examined seeds/pod, seed weight, seed quality, delayed maturation, pod malformation, reduced germination or progeny emergence, and malformed progeny. The vast majority of the studies did not investigate effects at rates as low as the NOAEC from the available vegetative vigor study. Monsanto's review of the available information indicated that the lowest effects endpoint reported from these studies was for delayed maturation of soybeans at rates as low as 0.56 g a.e./A from Kelley *et al.* (2005), which would still be almost 2 times less sensitive than the regulatory endpoint based on plant height that EFED has used in its risk assessments. Monsanto concluded that the open literature studies did not contain information that indicated that the in-field buffer based on plant height that is on the draft label would not also be protective of these reproductive effects.

EFED acknowledges Monsanto's submission of their analysis of the open literature data for effects to progeny, but to date has not independently reviewed each of these studies. However, for the following reason, EFED does not believe the information would change its risk assessments. The most sensitive endpoint reported in the open literature was a LOAEC of 0.56 g a.e./A for delayed maturation of soybeans (Kelley *et al.*, 2005; no NOAEC reported). As EFED's determination for risk to listed plant species is based on the most sensitive apical endpoint (*i.e.*, the NOAEC for soybean plant height from the available vegetative vigor study with dicamba DGA, 0.000261 lb dicamba a.e./A equivalent to 0.29 g a.e./ha, based on plant height), less sensitive endpoints reported in the literature for effects to progeny would not impact EPA's risk assessments. EFED's policy regarding open literature is that typically if endpoints from the open literature are not more sensitive than guideline endpoints, then further analysis is not required (USEPA, 2011b)

5. Revised Terrestrial Vertebrate Endpoints

Parent Dicamba

The risk assessment for the proposed new use on soybeans (USEPA, 2011. D378444) used the chronic endpoint from the rat 2-generation study (MRID 43137101), a NOAEL of 45 mg/kg-bw, based on decreased pup weight at 136 mg/kg-bw compared to the concurrent controls. HED recently reanalyzed the data from this study (USEPA, 2016, D431873) in comparison to the historical control database range and determined that the NOAEL and LOAEL should be raised to 136 and 450 mg/kg-bw, respectively, because pup weights in each generation in the 136 mg/kg-bw treatment group were within the historical control range and above the historical control mean for the F1, F2A and F2B generations. The revised T-REX run presented in **Section 6** of this addendum reflects the adjusted chronic endpoint for parent dicamba.

Metabolite DCSA

Following preliminary review of a rat 2-generation study with DCSA (MRID 47899517), the risk assessment for the proposed new use on soybeans (USEPA, 2011 D378444) used a chronic NOAEL endpoint of 37 mg/kg/d based on decreased parental bodyweight in the 362 mg/kg/d treatment group. However, since that assessment was completed, the chronic endpoint was revised in the final DER review (USEPA, 2012) and a recent memorandum for a benchmark dose analysis (USEPA, 2016) was completed to reflect the observed statistically significant decreases (6-9%) in offspring weight on 14 and 21 post-natal days (PND). The DER review from 2012 considered the LOAEL from effects to pup weight to be based on the male pre-mating dose of 37 mg/kg/d, with a corresponding NOAEL of 4 mg/kg/d. The recent benchmark dose analysis conducted by HED (USEPA, 2016) determined BMD₅ (estimated benchmark dose [BMD] to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) based on both the male pre-mating dose and the female lactation dose and noted that female lactation doses are more reflective (than male-premating doses) of pup exposure during the nursing period when the pup body weight decreased. This analysis concluded that the pup weight LOAEL and NOAEL threshold values based on the dam lactation doses would be 78 mg/kg/d and 8 mg/kg/d, respectively. HED also calculated a BMD₅ (estimated benchmark dose to result in 5% body weight change in pups from background levels) and BMDL₅ (the lower 95% confidence level on the BMD₅) of 38.6 and 34.9 mg/kg/d, respectively, based on the female lactation doses. In the revised T-REX analysis below, EFED used the NOAEL value of 8 mg/kg/d for risk estimation and further characterized the risk using the BMDL₅ of 34.9 mg/kg/d for DCSA effects to mammals.

No chronic data is available for the effects of the DCSA degradate to birds (or reptiles or terrestrial-phase amphibians, for which birds are surrogates). As a highly conservative approach, EPA will consider the toxicity differential for chronic effects between parent dicamba and the metabolite DCSA and apply a similar ratio to estimate chronic effects to avian organisms. Therefore, a factor of 17x (based on the chronic endpoints of 136 mg/kg-bw for parent dicamba and 8 mg/kg-bw for DCSA) is applied to the dicamba chronic NOAEC of 695 mg/kg-diet for the mallard duck, to result in a highly conservative estimate of a chronic NOAEC of 40.9 mg/kg-diet for birds for DCSA. This is considered a highly conservative approach as the chronic mammalian endpoint is based on effects to pups who would have been continually exposed to DCSA residues in utero and throughout lactation while chicks in the avian reproduction test would not be exposed to DCSA residues while still in the egg or post hatch.

6. Revised T-REX Analysis for Parent Dicamba and Quantitative Assessment of DCSA Exposure and Risk

Dicamba-specific Half-Life

In the risk assessment for the proposed new use on soybeans (USEPA, 2011), EFED modeled the dicamba residues using a single application (the T-REX model available at the time of the assessment was incapable of running applications with variable rates) and used the default foliar dissipation half-life value of 35 days. However, EFED has refined this analysis by modeling the residues using the maximum potential application rates with minimum application intervals (a 1 lb a.e./A application followed by two 0.5 lb a.e./A applications with a seven day interval between each application); a chemical-specific foliar dissipation half-life value for parent dicamba

(described below); and the new chronic mammalian endpoint for parent dicamba (described previously in **Section 5**).

EFED used residue data by Jimenez (1994; MRID 43370701) to calculate a dicamba specific foliar dissipation half-life. According to the available Health Effects Division (HED) review (DP Barcode 207649, 3/11/1996), this study was acceptable for use in risk assessment and indicated that there was no difference in foliar dissipation data between the various tested dicamba salt formulations (DMA, DGA and sodium salt formulations). Therefore, data for all dicamba salt formulations tested were used to calculate the final foliar half-life value.

Half-lives were calculated for each set of residue decline data based on the *NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* and using the PestDF package in the R statistical program. Each equation was evaluated for appropriateness before inclusion in the final half-life calculation. Individual decline data and estimated foliar half-life values are available in **Table 2**. A summary of this information is provided in the table below. The upper 90th percentile, one tailed, confidence interval of 8.4 days was used to calculate refined EECs in this assessment.

Table 2. Dicamba Half-Life (days) in Foliage					
Arithmetic Mean	Standard Deviation	Max Value	Min Value	Number of Values	Upper 90% CL on the mean
7.3	6.6	43.7	1.11	99	8.4

Parent Dicamba T-REX Analysis

Modeled maximum residue values (EECs) determined using this refined approach were slightly higher (~15%) than those determined in the original dicamba-tolerant soybean Section 3 assessment, but would not have impacted the screening-level risk conclusions for any assessed taxa. The previous risk assessment (2011) concluded that there was potential for direct adverse effects to mammals from chronic exposures of dicamba (max chronic RQ was 2.31 for small mammals consuming short grass). Following the refinements presented in this section (3 applications of dicamba to include the two post-emergent applications at the 0.5 lb a.e./A rate, foliar dissipation half-life decreased from 35 days to 8.4 days, and an increase in the mammalian chronic endpoint from 45 mg/kg-bw to 136 mg/kg-bw), there are no longer any exceedances for any size class of mammal consuming any dietary item (max RQ = 0.84, see **Appendix 1** for full T-REX input and output)

DCSA Metabolite Exposure Analysis

Since the chronic toxicity endpoints are more sensitive for DCSA than dicamba and DCSA residues were higher than dicamba residues within dicamba-tolerant soybean plant tissues (see below), EFED separately assessed the chronic exposure to DCSA residues for birds and mammals.

The available data indicate that DCSA has similar acute toxicity as parent dicamba, but is substantially more toxic on a chronic basis to mammals. In conventional soybean plants, DCSA residues following dicamba applications prior to planting were less than 2% of total dicamba residues in forage, hay and seed (MRIDs 43814101 and 44089307; max of 0.130 ppm DCSA, see **Appendix 2**) and would not be above toxicity thresholds for any taxa. However, in dicamba-tolerant soybean plants, dicamba is converted to DCSA and its glycosidic conjugates following demethylation of the aromatic methoxy moiety of dicamba (USEPA, 2013. HED residue chemistry summary) and in comparison to dicamba use on conventional soybeans, the maximum residues of DCSA in dicamba-tolerant soybean field trials following one 1-lb/A pre-emergent application and two 0.5-lb/A post-emergent applications were a substantially higher proportion of dicamba-related residues in forage, hay and seed (**Appendix 2** and MRID 47899524; 76%--88% of total dicamba-related residues). The empirical data from MRID 47899524 found means and maximums, respectively, of DCSA concentrations of 17.0 and 51.3 ppm, in forage 7-10 days following the last application, 32.2 and 61.1 ppm in hay 13-15 days following the last application and 0.059 and 0.440 ppm in seeds 73-98 days after the last application. EFED used the maximum measured values from the empirical data on forage, hay and seeds to assess risk to terrestrial vertebrates. There is some uncertainty in this approach as the maximum DCSA residues appear to be slightly increasing (16%) between forage at 7-10 days and hay at 13-15 days, however this could be due to the difference between fresher forage and drier hay, where DCSA has become more concentrated compared to the overall plant biomass, rather than due to additional conversion of dicamba residues to DCSA. Additionally, the amount of additional dicamba available to potentially convert to DCSA appears limited after this point as the maximum residues of dicamba were only 2.62 and 1.16 ppm in forage and hay, respectively.

Based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial vertebrates occurs as a result of feeding solely on DCSA in DT-soybean and no exposure to DCSA is expected for terrestrial vertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization. This is because the conversion of dicamba to DCSA in plants is only expected to occur in crops modified to be tolerant to dicamba.

DCSA Effects Assessment

No effects data are available for the chronic effects of DCSA to birds. EFED conservatively assumed that the ratio of parent dicamba to DCSA toxicity (17x differential) from the mammalian toxicity data could be applied to the chronic effects endpoint for birds, resulting in a chronic avian endpoint of 40.9 mg/kg-bw. However, since the DCSA chronic endpoint for mammals is based on effects to pups who were continually exposed in utero in the study, it may be conservative to assume that this toxicity differential in mammals for parent dicamba and DCSA would be equivalent for chicks who would not be exposed to DCSA residues during their gestation in the egg (beyond initial maternal transfer into the egg during egg development).

Using the empirical dataset for DCSA residues in DT-soybean crops (as described above), the maximum residues in soybean forage and hay tissue were 61.1 ppm and in seeds were 0.440 ppm. Residues in arthropods (as a dietary item for birds and mammals consuming insects that

have consumed soybean tissues with DCSA residues) were assumed to follow the Kenaga nomogram relationship between broadleaf plants and arthropods for spray applications and therefore were considered to contain 42.5 ppm. This is likely conservative, given that the residues from the nomogram are for external residues in food items following a spray application while the actual exposures would be internal residue concentrations in the plant. A screening assessment using this empirical data for the exposure values results in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay tissue or consuming insects that had consumed soybean tissues with DCSA residues (RQs range from **1.1—3.3**, **Table 3**), for small birds consuming forage and hay tissue or insects that had fed on DT-soybean tissues, (RQs range from **1.2—1.7**, **Table 4**) and medium birds feeding on forage/hay tissue (marginal exceedance of **1.0**) but no exceedances occurred for any size mammalian or avian granivore consuming soybean grain (max granivore RQ of < 0.01).

Table 3. Dose-based exposure, body-weight adjusted chronic endpoints and risk quotients for mammals consuming DT-soybean tissues containing DCSA residues (maximum 61.1 mg/kg in forage/hay, 0.44 mg/kg in seeds) or consuming arthropods that had fed on DT-soybean tissues (assumed to contain 42.5 mg/kg DCSA). Bold RQ values exceed the LOC.

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	Adjusted NOAEL (mg/kg-bw)	RQ
Small (15g)	Forage/Hay	0.0143	58.25	6.2	3.3
	Seed	0.00318	0.09	6.2	<0.01
	Arthropod	0.0143	40.52	6.2	2.3
Medium (35g)	Forage/Hay	0.0231	40.33	14.2	2.8
	Seed	0.00513	0.06	14.2	<0.01
	Arthropod	0.0231	28.05	14.2	2.0
Large (1000g)	Forage/Hay	0.153	9.35	17.6	1.5
	Seed	0.0340	0.01	17.6	<0.01
	Arthropod	0.153	6.50	17.6	1.1

Table 4. Dose-based exposure and risk quotients for birds consuming DT-soybean tissues containing DCSA residues (chronic endpoint assumes a 17x differential in toxicity between parent dicamba and DCSA for birds).

Size Class (g)	Dietary Item	Food Intake (k-diet/d)	Dose-based EEC (mg/kg-bw)	NOAEC (mg/kg-bw)	RQ
Small (20g)	Forage/Hay	0.0228	69.65	40.9	1.7
	Seed	0.0051	0.11	40.9	<0.01
	Arthropod	0.0228	48.45	40.9	1.2
Medium (100g)	Forage/Hay	0.0649	39.65	40.9	1.0
	Seed	0.0144	0.06	40.9	<0.01
	Arthropod	0.0649	27.58	40.9	0.7
Large (1000g)	Forage/Hay	0.291	17.78	40.9	0.4
	Seed	0.065	0.03	40.9	<0.01
	Arthropod	0.291	12.37	40.9	0.3

While this assessment used the comparison of the maximum residues detected with the chronic mammalian endpoint, there is some uncertainty due to the limited temporal sampling of DCSA residues in DT-soybean tissues (forage from days 7-10, hay from days 13-15 and seeds from

days 73-98) and therefore understanding formation/decline rates is not possible (to better understand potential maximum residues). Plant metabolism studies that track DCSA residues over time in all parts of DT-soybean plants following post-emergent applications would decrease this uncertainty. In the absence of this, EFED has used the best available data and the maximum measured residues to evaluate the chronic exposure.

As noted above, EFED calculated these RQs based on the female lactation dose NOAEL endpoint of 8 mg/kg/d from the DCSA 2-generation study where reductions of up to 9% pup body weight were observed 2-3 weeks post birth at the next highest dose (78 mg/kg/d). If the BMDL₅ (the lower 95% confidence level on the estimated benchmark dose to result in a 5% body weight change in pups from background levels) of 34.9 mg/kg/d calculated by HED (EPA, 2016) for DCSA was used in place of the NOAEL, then the maximum residues from the empirical data in soybean hay would be below the threshold dose for all size classes of mammals feeding on soybean plant tissue or soybean-consuming arthropods (RQs would range from 0.35—0.76 for mammals feeding on tolerant soybean tissues and 0.24—0.53 for mammals feeding on arthropods having consumed soybean tissues).

7. Terrestrial Invertebrates Risk Characterization

The initial 2011 risk assessment for dicamba use on tolerant plants (soybean use D378444, 3/8/2011) was conducted prior to EPA developing methods to quantitatively evaluate risks to pollinators. Consequently, that assessment included no quantitative analysis of the risk to beneficial terrestrial invertebrates posed by dicamba use patterns. Based on the acute contact data for the honey bee, the 2011 assessment qualitatively concluded that direct effects to listed terrestrial insect species were not expected.

In June 2014, President Obama issued a memorandum¹ establishing a Pollinator Health Task Force, co-chaired by USDA and EPA, to create a National Pollinator Health Strategy that promotes the health of honey bees and other pollinators (including birds, bats, butterflies, and insects). Consistent with this Presidential memorandum, the Office of Pesticide Programs (OPP) has been evaluating its own risk assessment methods to more quantitatively characterize pesticide risks to bees. This evolution has identified additional honeybee life stage testing and longer duration effects tests for adults (i.e., larval acute and chronic studies, and adult chronic studies) as potentially important to the risk assessment process.

This addendum document explains additional lines of evidence not considered in the 2011 risk assessment to better characterize the risk posed by dicamba uses to terrestrial invertebrates and ascertain if the lack of additional bee studies (including chronic adult honey bee data and acute and chronic larval honey bee data) is a significant limitation to making a more definitive characterization. The characterization of the chronic risks to adult and larval bees presented here is a novel approach using the best available data. However, this approach is not meant to preclude potential requests for additional terrestrial invertebrate data or represent a new framework for EPA assessments for estimating potential risks to beneficial terrestrial

¹ <https://www.whitehouse.gov/the-press-office/2014/06/20/presidential-memorandum-creating-federal-strategy-promote-health-honey-b>

invertebrates. EPA's established methodology for evaluating risks to pollinators can be found in the Guidance for Assessing Pesticide Risks to Bees (USEPA, 2014) and relies on a full suite of honey bee laboratory data including acute and chronic effects studies to adult and larval honey bees to fully estimate risk to bees.

Acute Contact and Dietary Exposure to Adult Honey Bees

On an acute contact exposure basis, dicamba is classified as 'practically non-toxic' to non-target insects including honey bees (honey bee acute contact $LD_{50} > 91 \mu\text{g a.e./bee}$ (MRID 00036935). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LD_{50} (conservatively assuming that the highest tested dose would result in 50% mortality where in that study, mortality at that dose was only 2.5%) and determining acute contact exposure from a direct spray of dicamba as the maximum single application rate ($1.0 \text{ lbs a.e./A} \times 2.7 \mu\text{g a.e./bee}$ (upper bound for contact exposures from a direct spray of 1 lb a.e./A , based on work by Kock and Weisser, 1997), the resultant RQ would be 0.03 ($2.7/91$) or 1 order of magnitude less than the terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative. Although this is for only a single application of dicamba, it may be considered an appropriate estimate of exposure from a direct spray as there is a 7-day minimum interval between applications and the lifespan of a bee as a forager is 4-5 days (Winston, 1987). Therefore, the risk to adult honey bees posed by contact with residues of dicamba in spray drift is considered low.

Acute dietary data for non-target insects has not been submitted to the Agency. However, a review of the EU Footprint Pesticide Properties Database reported an acute oral value for honey bees that indicates dicamba is also practically non-toxic to non-target insects on an oral exposure basis (honey bee acute oral $LC_{50} > 100 \mu\text{g a.e./bee}$). If an RQ were calculated for terrestrial invertebrates,² using this non-definitive LC_{50} (and again, conservatively assuming that the highest tested dose would result in 50% mortality) and determining acute dietary exposure of dicamba residues of $32.12 \mu\text{g/bee/bee/day}$ ($1.0 \text{ lb a.e./A} \times 110 \mu\text{g a.e./g}$ {upper-bound residue for tall grass from T-REX} $\times 0.292 \text{ g/day}$ {pollen consumption rate}), the resultant RQ would be 0.32 ($32.12/100$) or slightly below the proposed terrestrial invertebrate LOC (0.4). Given that the actual dose that would result in 50% mortality is likely considerably higher than $100 \mu\text{g a.e./bee}$, this analysis can be considered highly conservative.

Chronic Oral Exposures to Adult and Larval Honey Bees

Approach

The Office of Pesticide Program's overview of the FIFRA risk assessment process (USEPA 2004) states the following:

In some instances, a core study may not be available for a particular data requirement listed in 40 CFR 158. In this case, the risk assessment team may

² The employed methodology for calculating an RQ for pollinators was first proposed in the 2012 Pollinator Risk Assessment Framework SAP White Paper, and subsequently validated by the panel. The White Paper is accessible online at [regulations.gov](https://www.regulations.gov), under docket EPA-HQ-OPP-2012-0543.

consider other sources of information to address the data gap.... Professional judgment is used by the risk assessment team to determine the utility of the available supplemental data for the proposed risk assessment. (page 36 USEPA 2004)

EFED has employed, for the last decade, an acute to chronic ratio approach (USEPA 1999, Mount et al. 2003) to address data uncertainty for a variety of endpoints including survival, growth, development, and reproduction effects from prolonged exposure. The process uses mathematical relationships observed between acute and chronic exposure effects endpoints conducted with one organism to draw inferences on the potential effects endpoints associated with longer duration exposures in another organism, where only acute exposure effects endpoints have been measured. Consistent with this approach, an evaluation of the invertebrate data uncertainties for dicamba focuses on the acute and chronic toxicity data for other invertebrates to determine a relative relationship between the acute toxicity endpoints and the chronic endpoints. This relationship is then examined relative to the acute toxicity data available for the dicamba equivalence (a.e.) endpoints for bees to estimate a chronic endpoint for terrestrial invertebrates. The estimated chronic/developmental endpoint is compared to available exposure information to determine if a presumption of risk is or is not supported by these lines of evidence.

Aquatic invertebrates were selected for this approach 1) because they represent a relatively closer taxonomy to terrestrial invertebrates than would be achieved for tested vertebrate species and 2) because of a lack of a specific taxonomically-based mechanism of action for invertebrate responses to dicamba DGA salt. Moreover, the chronic data available for aquatic invertebrates includes measures of effects on survival, reproduction, growth, and development milestones over protracted exposure windows, which are conservatively applicable to the growth, development and survival measurement endpoints expected from acute and chronic bee larval and adult bee chronic studies.

Analysis

The available data from the soybean risk assessment for honeybees and for freshwater invertebrates are summarized below:

Acute <i>Daphnia magna</i>	EC ₅₀ > 100 mg a.e./L	MRID 40094602
Chronic <i>Daphnia magna</i>	NOAEC = 42 mg a.e./L ³	MRID 48718007
Acute Honey bee contact	LD ₅₀ > 91 µg a.e./bee	MRID 00036935
Acute Honey bee oral	LD ₅₀ > 100 µg a.e./bee	EU Footprint Database ⁴

Although the acute daphnid data are non-definitive, a comparison of the acute and chronic endpoints, in the case of *D. magna*, indicates generally low acute and chronic toxicity to aquatic invertebrates with a relationship between the acute median lethal toxicity threshold (EC₅₀) and the chronic no observed adverse effect concentration (NOAEC) of > 2.38 (>100/42 = >2.38).

³ Test material was dicamba BAPMA salt

⁴ EU Pesticide Properties Database (PPDB), <http://sitem.herts.ac.uk/aeru/ppdb/en/Reports/213.htm>

Applying the minimum that this factor could be to the available honey bee median lethal endpoint would yield estimates of chronic endpoints of 38 µg a.e./bee for contact exposure and 42 µg a.e./bee for oral exposure. Although these estimates may lack conservatism since the ratio of acute to chronic toxicity in the daphnid data set may be greater than 2.38, the estimated endpoints may still be conservative since the acute values for bees were also not definitive (*i.e.*, the highest dose tested was below lethal levels so an actual LD₅₀/LC₅₀ were not demonstrated), so the actual acute median lethal value is likely to be greater and yield higher (less sensitive) estimates of chronic effect threshold.

Following EPA's framework for assessing pesticide risks to bees (USEPA, 2014), the acute contact estimated exposure level from dicamba DGA is 2.7 µg a.e./bee for the maximum 1 lb a.e./A application rate. This exposure level is over an order of magnitude lower than the estimated contact-based bee chronic NOAEC of 38 µg a.e./bee. The acute dietary estimated exposure level for adult honeybees is 32.12 µg/bee/day for the maximum 1 lb a.e./A application rate, which is also lower than the ACR-estimated oral exposure chronic bee endpoint of 42 µg a.e./bee. In both cases, the estimated exposure level is below the estimated chronic toxicity endpoint for survival, developmental, and reproductive effects for honeybees under prolonged exposures, even without considering that the acute endpoints in honeybees are very conservative estimates.

Adult honeybee effects following chronic exposure effects are adequately addressed by this approach as well because the endpoint for such a test is survival under prolonged exposure and the underlying chronic exposure endpoints used in the approach were conducted at levels producing no adult invertebrate mortality. Also it is reasonable to expect that effects measures under longer term studies are a conservative surrogate for short duration exposure effects (e.g., an acute larva study measuring survival).

Because honeybee risk assessment results serve as a surrogate for assessing risks to other terrestrial invertebrates, the findings above indicate no concern for risks to the taxon overall. However, there are uncertainties inherent in the evaluation:

1. *D. magna* chronic studies incorporate long exposure periods and measure survival, growth and development of a juvenile crustacean life stage, which are also evaluated endpoints in acute and chronic for larval honeybee studies, but the mechanism of action may not be exactly a match for non-crustacean arthropods such as larval insects. However, given that very similar aquatic effects extrapolations are made across a variety of aquatic invertebrate taxa, including insects, the uncertainty herein is no greater than the acceptable level of uncertainty in the aquatic invertebrate extrapolations routinely employed for aquatic effects characterizations.
2. Routes of exposure between aquatic organism toxicity tests and honeybee tests are not the same. Exposure media in aquatic invertebrate testing is via water, but for chronic exposure studies feeding occurs so some oral exposure via diet is probable. Larval honeybee testing involves both dietary and dermal exposure under the laboratory testing conditions, and adult chronic honeybee studies involve dietary

exposure. However, for a chemical such as dicamba DGA salt, once dissociated in test solution to the free acid, the exposure differences are likely not biologically significant as the uptake for the hydrophilic acid is likely diffusion across the membrane with other water soluble compounds and therefore absorption for either the gut or gill would be similar, though metabolic pathways may be different following uptake through the gill compared with the gut.

The refined investigation in this document considered other lines of evidence and focused on:

1. A long standing EFED approach to consider the relationship between acute and chronic endpoints in the complete dataset for one organism to draw inferences on the same endpoints for another organism when data are lacking (i.e., inferring survival, growth and development effects levels for terrestrial invertebrate developmental life stages and survival in organisms following prolonged exposure); and
2. Comparison of resulting extrapolated invertebrate development, growth and reproduction endpoints under chronic exposure conditions to estimated levels of exposure.

Considering all lines of evidence, it is reasonable to conclude that risks are likely to be low to larval and adult honey bees under the conditions described in the soybean risk assessment scenarios of use as the empirical data demonstrate low acute and chronic toxicity to other similar taxa (*i.e.* aquatic invertebrates), low acute toxicity to adult honey bees and based on the ACR analysis presented here, chronic toxicity to adult and larval honey bees is also anticipated to be low. Additionally, dicamba will be reassessed in registration review [beginning in summer, 2016]. EPA intends to use Registration Review to facilitate submittal of additional pollinator data and is also revising the existing insect pollinator data requirements in CFR Part 158 (revision anticipated in 2017) to require additional data necessary to complete risk assessments consistent with the risk assessment framework. Consistent with current use of bee endpoints as a surrogate for other terrestrial invertebrates, there is sufficient information to preclude concern for direct terrestrial invertebrate risks and any attendant indirect effects mediated through these organisms.

No data is available for the acute or chronic toxicity of dicamba's degradate DCSA to honey bees or other pollinators (the EU footprint database does however report a 14-D LC₅₀ of > 1000 mg/kg for earthworms). However, given the low DCSA residues measured in dicamba-tolerant seeds (max measured residue of 0.440 ppm), exposures to honey bees and other pollinators from DCSA residues in pollen and nectar of dicamba-tolerant soybean are anticipated to be low.

As noted above for terrestrial vertebrate species, based on the available plant metabolism data for DCSA on non-DT plants, EFED assumed that any exposure for terrestrial invertebrates occurs as a result of feeding solely on DCSA in DT-soybean plant tissues and no exposure to DCSA is expected for terrestrial invertebrates feeding off the field, even if dicamba residues should occur following spray drift or volatilization.

8. *Runoff*

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting. However, in the following paragraphs the Agency provides an explicit consideration of the runoff risks and effects of proposed mitigation to limit off-site runoff in listed species effects determination.

An important component of the model used for terrestrial risk assessment (TerrPlant) is the assumption that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The TerrPlant model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass. The model also includes an assumption that the non-target plant receptors in the runoff zone are exposed to a single pulse of the total mass. The TerrPlant model does not account for any pesticide degradation or partitioning, nor does it account for the temporal aspects of runoff associated with meteorological events (i.e., runoff follows precipitation events that exceed field capacity of the soil). According to the original ecological risk assessment (USEPA, 2011a), dicamba is not environmentally persistent. Therefore, TerrPlant is likely providing a highly conservative estimate of runoff loading at any given time because the processes of degradation and partitioning combined with the stochastic nature of runoff are important limiting factors for dicamba.

A refined characterization of potential pesticide runoff is routinely considered in aquatic system exposure modeling through the use of the Surface Water Concentration Calculator (SWCC). EFED has turned to this model to ascertain the extent to which explicit consideration of degradation, partitioning, and stochastic runoff events would lead to a more mechanistically appropriate runoff exposure estimate than is possible using TerrPlant. Using the SWCC Missouri cotton scenario run for the cotton risk assessment (D404823) and assuming one application of dicamba DGA at 1 pound per acre, followed by two half-pound applications at seven-day intervals, EFED has determined that the total yearly mass of dicamba in runoff from a 10 hectare (24.7 acre) treated field is ~0.055% of the applied mass (see **Appendix 3** for calculations). Using these assumptions in TerrPlant (total 2 lb ae/A application and a 0.055% runoff fraction), and the most sensitive endpoint of 0.000261 for the NOAEC for soybeans, the maximum RQ is less than the LOC of 1.0 by a factor of at least 2 (RQs range from <0.1 to 0.48, see **Appendix 3**).

Combining the predictions of SWCC modeling and the expectation that much of the off-site plant community will not experience foliar contact with dicamba DGA in runoff sheet flow, EFED concludes that all available lines of evidence support a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA.

9. *Herbicide Interactions (Synergism)*

Mixtures of herbicides, such as those applied in tank mixtures, may cause synergistic, antagonistic, or additive effect in non-target plants, compared to the effects of the individual herbicides. The patent and literature studies cited below indicate that combinations of dicamba

and glyphosate may cause effects that range from synergistic to antagonistic, depending on the plants tested and the doses used.

In the case of dicamba and glyphosate, a patent application (Satchivi and Wright 2011) filed by DowAgrosciences LLC claimed synergistic effects in *Chenopodium album* (common lambsquarters) and *Commelina benghalensis* (dayflower), but no synergism in *Conyza canadensis* (Horseweed/marestail).

Flint and Barrett (1989a) studied the combined effects of dicamba and glyphosate on field bindweed (*Convolvulus arvensis*) and found synergistic inhibitory effects on the root system. Flint and Barrett (1989b) also studied interactions between dicamba and glyphosate in Johnsongrass (*Sorghum halepense*). They found antagonistic effects of dicamba on shoot and root fresh weights, compared to lower rates of glyphosate alone.

Kelley et al. (2005) studied the interactions of dicamba with four herbicides, including glyphosate, in non-GMO soybeans. Dicamba was not found to be synergistic with glyphosate considering plant injury and yield loss as endpoints.

Olszyk et al. (2015) tested the interaction of dicamba and glyphosate (at three different rates) in eight plant species, including big bluestem (*Andropogon gerardii*), Milkweed (*Asclepias syriaca* spp.), purple node joe pye weed (*Eutrochium purpureum*), soybean (*Glycine max*), evening primrose (*Oenothera biennis*), slender knodding smartweed (*Polygonum lapathifolium*), Canada goldenrod (*Solidago canadensis*), and purple top tridens (*Tridens flavus*). Generally, antagonistic effects were found in plant growth endpoints and the study authors concluded that no combination of dicamba with differing glyphosate rates produced a synergistic response for any species.

The current draft label for dicamba use on tolerant soybean and cotton plants specifies that tank mixes may only be used for products that have been tested and found not to have unreasonable adverse effects on the spray drift properties of M1691 Herbicide. EFED believes that guideline laboratory studies of effects to terrestrial plants should be required for any product or tank mixture combining dicamba and other active ingredients to assess risks associated with any tank mixture for use on dicamba-tolerant soybeans or cotton. Testing of such products should include the standard suite of tested species from the already submitted dicamba and tank mixed active ingredient vegetative vigor studies as well as those that the open literature and patent data indicate potential for synergistic effects.

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Appendix 1: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans

Chemical Identity and Application Information

Chemical Name: Dicamba

Seed Treatment? (Check if yes) ☐

Use:

Product name and form:

% A.I. (leading zero must be entered for formulations <1% a.i.):

Half-life (days):

Are you assessing applications with variable rates or intervals? ☒

Seeding Rate (lbs/acre) 166.7

Reset Model

Assessed Species Inputs (optional, use defaults for RQs for national level assessments)

What body weight range is assessed (grams)?	Birds	Mammals
Small	20	15
Medium	100	35
Large	1000	1000

Application No.	Rate	Day of Application
1	1	0
2	0.5	7
3	0.5	14
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

The value in G6 must be zero

Note: Sources of wildlife diet are assumed to be available for less than one year for this model.

Endpoints

Avian

Endpoint	Toxicity value	Indicate test species below
LD50 (mg/kg-bw)	188.00	<input type="text" value="Subacute oral"/>
LC50 (mg/kg-diet)	10000.00	<input type="text" value="Subacute oral"/>
NOAEL (mg/kg-bw)		<input type="text" value="Subacute oral"/>
NOAEC (mg/kg-diet)	695.00	<input type="text" value="Mixed oral"/>

Optional Test Organism in body weight (g)

Optional Test Species Name	Toxicity Value Reference (MRID)

Enter the Mineau et al. Scaling Factor 1.15

Mammalian

Endpoint	Toxicity value	Acute Study	Chronic Study
LD50 (mg/kg-bw)	2740.00	350	350
LC50 (mg/kg-diet)			Reference (MRID)
Reported Chronic Endpoint	136.00	mg/kg-bw	
Is dietary concentration (mg/kg-diet) reported from the available chronic mammal study? (yes or no)	no		

Estimated Chronic Diet Concentration Equivalent to Reported Chronic Daily Dose 2720

mg/kg-diet based on standard FDA lab rat conversion

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	135.44	299.47	2.21	137.26	1.01	168.45	1.24	18.72	0.14	117.29	0.87	4.16	0.03
100	172.42	170.77	0.99	78.27	0.45	96.06	0.56	10.67	0.06	66.88	0.39	2.37	0.01
1000	243.55	76.46	0.31	35.04	0.14	43.01	0.18	4.78	0.02	29.94	0.12	1.06	0.00

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients										
LC50	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
10000	262.94	0.03	120.52	0.01	147.91	0.01	16.43	0.00	102.99	0.01

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients

NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
695	262.94	0.38	120.52	0.17	147.91	0.21	16.43	0.02	102.99	0.15

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted LD50	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	6022.06	250.70	0.04	114.90	0.02	141.02	0.02	15.67	0.00	98.1893	0.0163	3.4819	0.0006
35	4872.49	173.26	0.04	79.41	0.02	97.46	0.02	10.83	0.00	67.8619	0.0139	2.4065	0.0005
1000	2107.50	40.17	0.02	18.41	0.01	22.60	0.01	2.51	0.00	15.734	0.0075	0.5579	0.0003

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients										
LC50 (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	262.94	#DIV/0!	120.52	#DIV/0!	147.91	#DIV/0!	16.43	#####	102.99	#DIV/0!

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients										
NOAEC (ppm)	EECs and RQs									
	Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds/Large Insects		Arthropods	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
2720	262.94	0.10	120.52	0.04	147.91	0.05	16.43	0.01	102.99	0.04

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients													
Size Class (grams)	Adjusted NOAEL	EECs and RQs											
		Short Grass		Tall Grass		Broadleaf Plants		Fruits/Pods/Seeds		Arthropods		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	298.90	250.70	0.84	114.90	0.38	141.02	0.47	15.67	0.05	98.19	0.33	3.48	0.01
35	241.85	173.26	0.72	79.41	0.33	97.46	0.40	10.83	0.04	67.86	0.28	2.41	0.01
1000	104.61	40.17	0.38	18.41	0.18	22.60	0.22	2.51	0.02	15.73	0.15	0.56	0.01

Appendix 2. Dicamba Crop Field Trial Residue Data Which Include the Determination of the DCSA Metabolite.

Table 1. Summary of Residues from Conventional Asparagus Crop Field Trials with DCSA as a Dicamba Residue of Concern.¹

Formulation ²	Total Application Rate (lb ae/A)	PHI (days)	N ³	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁵	HAFT ⁵	Median ⁵	Mean ⁵	SD ⁵
4 lb ae/gal DGA SL, 4 lb ae/gal DGA SL, and 2 lb ae/gal Na SL	Single post-emergence broadcast application of 0.5 lb ae/A	1	24	Parent	0.266	3.274	0.304	3.144	0.604	0.967	0.852
				DCSA ⁴	<0.01	0.071	<0.01	<0.040	0.011	0.014	0.0069
				Total	0.271	3.192	0.314	3.166	0.622	0.981	0.854

¹ Asparagus data are taken directly from MRID Nos. 43245206 and 43425803 (D204488, D204809, and D209229, L. Cheng, 07/14/1997) used for tolerance re-assessment in the 2005 RED.

² Test applications included the dimethylamine (DMA), diglycolamine (DGA), and sodium (Na⁺) salt formulations.

³ number of samples.

⁴ DCSA is the 3,6-dichloro-2-hydroxybenzoic acid metabolite.

⁵ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 2. Summary of Residues from Conventional Soybean Crop Field Trials (Seed) with DCSA as a Dicamba Residue of Concern.^{1,2}

Formulation ³	Total Application Rate (lb ae/A)	PHI (days)	N ⁴	Residue of Concern	Combined Residues (ppm)						
					Min.	Max.	LAFT ⁶	HAFT ⁶	Median ⁶	Mean ⁶	SD ⁶
4 lb ae/gal DMA SL	Single 0.5 lb ae pre-plant treatment followed by a single post-emergence application of 2.0 lb ae/A	7	24	Parent	0.027	8.10	0.038	7.40	0.72	1.022	1.703
				DCSA ⁵	<0.01	0.130	<0.01	<0.048	.014	0.02	0.015
				5-OH dicamba	<0.01	0.360	<0.01	0.26	0.01	0.043	0.071
				Total	0.047	8.14	0.084	7.44	0.768	1.085	1.713

¹ Soybean grain data are for the 1X rate which used a 0.5 lb ae/A treatment made at 14-days pre-planting followed by a 2.0 lb ae/A treatment made at 7-days prior to harvest taken directly from MRID Nos. 43814101 (D223283, S. Knizner, 07/29/1996) and 44089307 (D228703, S. Chun, 07/16/1998) used for tolerance reassessment in the 2005 RED.

² The registrant was not supporting tolerances for soybean forage and hay at this time in lieu of a feeding restriction placed on the label. However, data were included for these commodities in the study submissions acquired using a single 0.5 lb ae/A treatment made at 14-days pre-planting (0.25x the maximum rate). Total residues of dicamba (parent, DCSA, and 5-OH dicamba) were <0.03 - <0.097 ppm in soybean forage and <0.03 - <0.04 ppm in soybean hay.

³ Test applications included the dimethylamine (DMA) salt formulation.

⁴ number of samples.

⁵ DCSA is the 3,6-dichloro-5-hydroxybenzoic acid metabolite.

⁶ Values based on per-trial averages. LAFT = lowest average field trial, HAFT = highest average field trial, SD = standard deviation. For computation of the LAFT, HAFT, median, mean, and standard deviation, values < LOQ are assumed to be at the LOQ (0.01 ppm).

Table 3. Summary of Residues from Dicamba-Tolerant Cotton Crop Field Trials with DCSA as a Dicamba Residue of Concern.											
Commodity	Analyte	Total App. Rate lb ae/A (kg ae/ha)	PHI (days)	Residue Levels (ppm) ¹							
				n	Sample Min.	Sample Max.	LAFT ²	HAFT ²	Median	Mean	Std. Dev.
TRT 2 (Applications at Preemergence, 6-leaf stage, and first white flower + 15 days; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	49-105	13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.23	<0.02	0.23	0.02	0.04	0.06
	Combined Residues			13	<0.06	<0.28	<0.06	<0.28	0.06	0.09	0.06
Gin byproducts	Dicamba	2.0 (2.2)	82-84	3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	5-OH Dicamba			3	<0.04	<0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	0.39	1.73	0.43	1.58	0.67	0.89	0.61
	Combined Residues			3	<0.47	<1.82	<0.53	<1.66	0.75	0.97	0.61
TRT 3 (Applications at Preemergence, first open boll stage, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	6-8	13	0.06	1.97	0.06	1.38	0.65	0.64	0.43
	5-OH Dicamba			13	<0.02	0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			13	<0.02	0.25	<0.02	0.16	0.03	0.05	0.05
	Combined Residues			13	<0.12	<2.24	<0.10	<1.56	0.71	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Undelinted Cotton seed	Dicamba	2.0-2.1 (2.2-2.4)	6-8	13	0.09	1.54	0.12	1.42	0.47	0.61	0.41
	5-OH Dicamba			13	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	N/A
	DCSA			13	0.02	0.27	0.02	0.27	0.06	0.08	0.07
	Combined Residues			13	<0.13	<1.83	<0.16	<1.72	0.56	0.71	0.48
TRT 4 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: Clarity)											
Gin byproducts	Dicamba	2.0 (2.2)	6-7	3	3.09	23.6	3.13	23.0	14.9	13.7	10.0
	5-OH Dicamba			3	<0.04	0.04	<0.04	<0.04	0.04	0.04	N/A
	DCSA			3	1.70	6.29	1.78	6.17	4.50	4.15	2.22
	Combined Residues			3	<4.83	29.9	<5.06	<29.6	19.7	18.1	12.2
TRT 5 (Applications at 6-leaf, first white flower + 15 days, first open boll, and 7 days prior to harvest; EP: MON 11968)											
Undelinted Cotton seed	Dicamba	2.0 (2.2)	7-8	4	0.17	0.72	0.20	0.62	0.41	0.41	0.23
	5-OH Dicamba			4	<0.02	<0.02	<0.02	<0.02	0.02	0.02	N/A
	DCSA			4	0.02	0.17	0.02	0.12	0.04	0.06	0.04
	Combined Residues			4	<0.21	<0.91	<0.24	<0.76	0.47	0.49	0.27

¹ Except for sample min/max, values reflect per trial averages; n = no. of field trials. For calculation of median, mean, and standard deviation, the LOQ (0.02 ppm each analyte in undelinted cotton seed and 0.04 ppm for each analyte in cotton gin byproducts) was used for any results reported as <LOQ in Table C.3. Combined residues of dicamba, 5-OH dicamba, DCSA, and DCSA are expressed in parent equivalents. Individual analyte results are reported as per se. N/A = Not applicable.

² LAFT = lowest-average-field-trial; HAFT = highest-average-field-trial.

Table 4. Summary of Residues from Dicamba-Tolerant Soybean Crop Field Trials with DCSA as a Dicamba Residue of Concern.									
Commodity	Total Applic. Rate lb a.e./A (kg a.e./ha)	PHI (days)	Residue Levels ^{a, b} (ppm)						
			N	Min.	Max.	HAFT	Median (STMdR)	Mean (STMR)	Std. Dev.
DCGA ^c									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	0.356	5.90	5.27	1.93	2.02	1.02
Hay		13-15	44	0.167	7.26	7.19	2.00	2.66	1.91
Seed		73-98	44	<0.011	0.135	0.131	0.017	0.032	0.029
DCSA									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	8.92	51.3	50.4	15.0	17.0	8.00
Hay		13-15	44	12.2	61.1	60.7	31.9	32.2	11.2
Seed		73-98	44	0.010	0.440	0.439	0.033	0.059	0.089
Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	2.62	2.47	0.068	0.374	0.603
Hay		13-15	44	<LOQ	1.16	1.01	0.051	0.130	0.216
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
5-OH Dicamba									
Forage	1.96-2.04 (2.19-2.28)	7-10	44	<LOQ	0.009	0.009	0.005	0.006	<LOQ
Hay		13-15	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Seed		73-98	44	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

^aConcentrations of the individual analytes are reported as dicamba equivalents

^bValues < LOQ are assumed to be at the LOQ.

^c DCGA residues were quantitated by a non-validated method

Appendix 3: Runoff Calculations from SWCC and Resulting RQ values in TerrPlant

Summary of Water Modeling of dicamba and the USEPA Standard Pond

Estimated Environmental Concentrations for dicamba are presented in **Table 1** for the USEPA standard pond with the MScottonSTD field scenario. A graphical presentation of the year-to-year peaks is presented in **Figure 1**. These values were generated with the Surface Water Concentration Calculator (SWCC Version 1.106). Critical input values for the model are summarized in **Tables 2** and **3**.

This model estimates that about 22% of dicamba applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (76.7% of the total transport), followed by spray drift (23.1%) and erosion (0.18%). In the water body, pesticide dissipates with an effective water column half-life of 106.0 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 107.2 days) followed by photolysis (9502 days) and volatilization (141341.2 days). In the benthic region, pesticide dissipates very slowly (622.2 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 622.2 days). The pesticide is about evenly distributed in the benthic region between the pore water and sorbed to sediment.

Table 1. Estimated Environmental Concentrations (ppb) for dicamba.

Peak (1-in-10 yr)	42.2
4-day Avg (1-in-10 yr)	41.7
21-day Avg (1-in-10 yr)	40.1
60-day Avg (1-in-10 yr)	35.6
365-day Avg (1-in-10 yr)	13.8
Entire Simulation Mean	8.49

Table 2. Summary of Model Inputs for dicamba.

Scenario	MScottonSTD
Cropped Area Fraction	1
Koc (ml/g)	13.4
Water Half-Life (days) @ 25 °C	72.9
Benthic Half-Life (days) @ 25 °C	423
Photolysis Half-Life (days) @ 40	105

°Lat	
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 25 °C	18
Foliar Half-Life (days)	35
Molecular Wt	221
Vapor Pressure (torr)	3.41E-5
Solubility (mg/l)	6100

Table 3. Application Schedule for dicamba.

Date (Mon/Day)	Type	Amount (kg/ha)	Eff.	Drift
04/16	Ground	1.12	0.99	0.05
04/23	Ground	0.56	0.99	0.05
04/30	Ground	0.56	0.99	0.05

Figure 1. Yearly Peak Concentrations

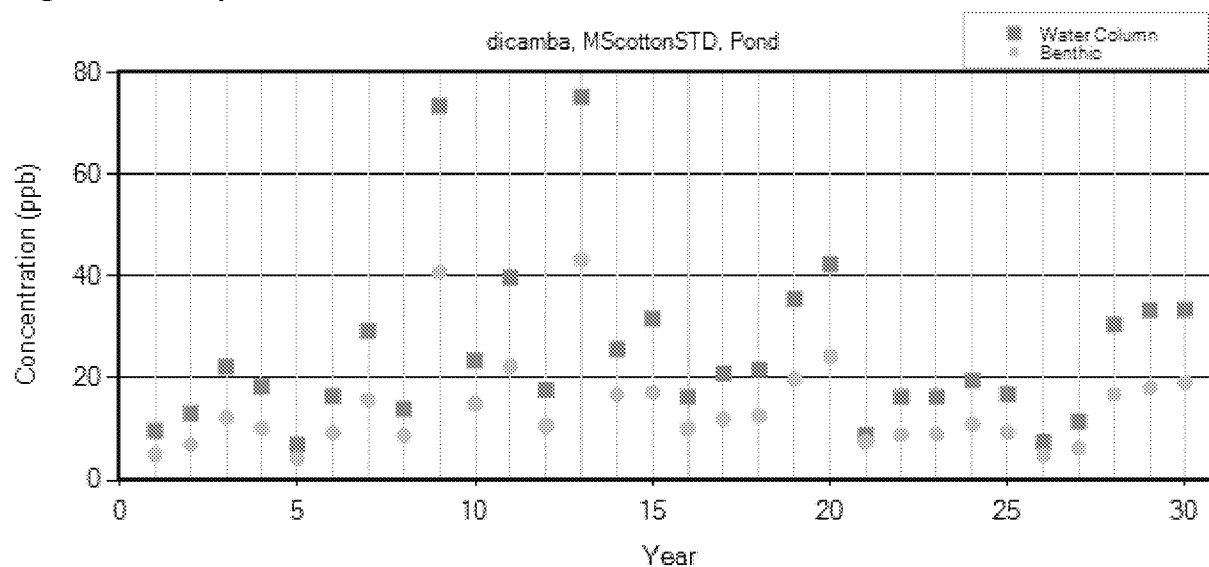


Table 4. Alternative dicamba runoff analysis based on MS cotton SWCC run at 2 lb/A (maximum annual application rate for dicamba based on a 1 lb a.e./A application and two 0.5 lb a.e./A applications.

Sources	Contribution factor	Total mass (kg) based on 30 years	Total mass applied over 30 year period	Percentage of dicamba over 30 year period	Average annual loss (%)
Runoff	0.7669	11.14	672	1.66	0.055
Erosion	0.0018	0.02634		0.0039	0.00013
total	0.7687	11.17		1.7	0.056

Comparison of the most sensitive terrestrial and aquatic endpoints for use in the runoff calculations.

Comparing most sensitive IC₂₅/NOAEC for non-vascular aquatic plants and terrestrial plants. Most sensitive species are the blue green algae (IC₅₀/NOAEC of 0.061/0.005 mg ae/L) and soybean IC₂₅/NOAEC of 0.000513/0.000261 lbs ae/A.

To compare, assume exposure is equivalent to a 1-acre field covered with 1 inch of water. Therefore the EEC in lb/A that compares to an IC₅₀ of 0.061 mg ae/L for blue-green algae can be considered following **Equation 1** below:

Equation 1.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (102,790 \text{ L water/ Acre-in}) * (1 \text{ inch}) * (1 \text{ lb/ } 453,592 \text{ mg})$
which reduces to:

Equation 2.

$EEC \text{ lb a.e./Acre} = (Z \text{ mg/L}) * (0.226613)$

$EEC \text{ lb ai/A} = 0.061 \text{ mg/L} * 0.226613 = 0.0138$

and the EEC in lb/a that compares to a NOAEC of 0.005 mg ae/L for blue-green algae would be $EEC \text{ lb ae/A} = 0.005 \text{ mg/L} * 0.226613 = 0.0011$. These endpoints are approximately 1-2 orders of magnitude less sensitive than the soybean endpoints. Therefore, the soybean endpoints should be used in the revised TerrPlant runoff calculations.

Table 5. RQ values calculated in TerrPlant for plants in dry and semi-aquatic areas exposed to Dicamba DGA salt through runoff. Conservative assumptions of 2 lb a.e./A application rate and 0.06% loss through runoff and erosion.

Plant Type	Listed Status	Dry	Semi-Aquatic
Monocot	non-listed	<0.1	<0.1
Monocot	listed	<0.1	<0.1
Dicot	non-listed	0.17	0.26
Dicot	listed	0.32	0.48



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444
Decision: 432752

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (ERB6) 3-8-11
MWagman 3/8/11

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects



to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equatoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

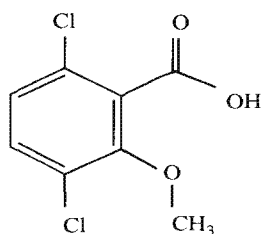
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see **Table 1**). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

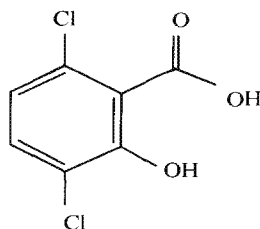
SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



Dicamba
3,6-dichloro-o-anisic acid



DCSA
3,6-dichlorosalicylic acid

BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equatoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systematically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

TABLE 2: Dicamba TGA Proposed Use Pattern for Dicamba Tolerant Soybean							
Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		
¹ - M1691 Herbicide ² - Registered uses ³ - "Acid equivalent" ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential loans. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see **Fig. 2**). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

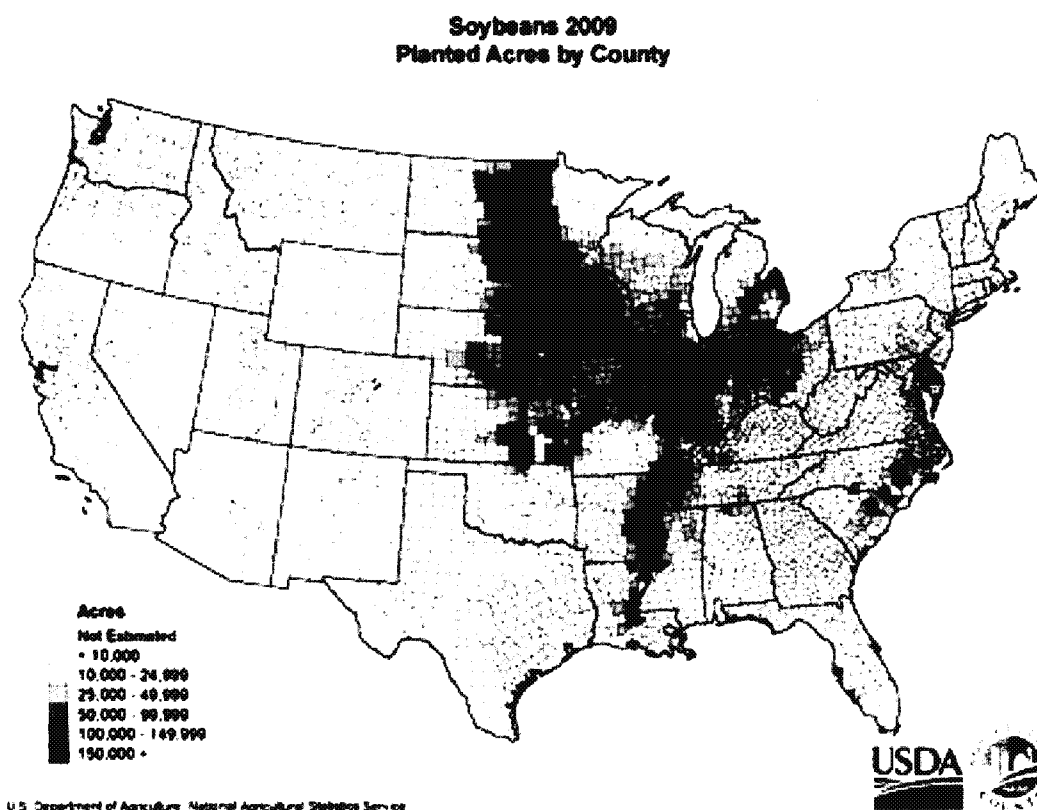


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
 (http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in **Table 7**. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀ is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see **Table 9** and **APPENDIX IV**). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see **Table 10** and **APPENDIX IV**).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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APPENDIX I

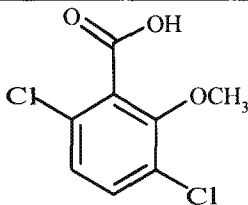
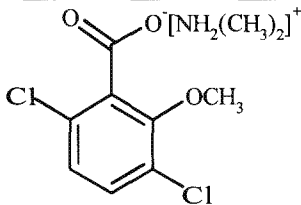
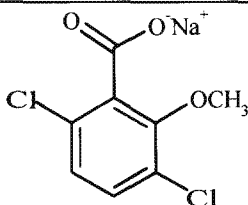
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

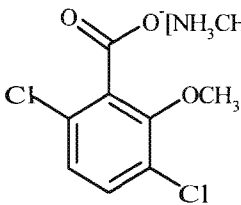
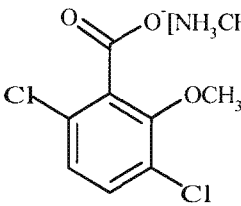
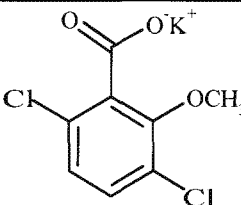
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
<i>Degradate</i>	<i>Max Degradate Concentration (% of applied)</i>						
	<i>Hydrolysis</i>	<i>Aqueous Photolysis</i>	<i>Soil Photolysis</i>	<i>Aerobic Soil Metabolism</i>	<i>Anaerobic Aquatic Degradation</i>	<i>Aerobic Aquatic Degradation</i>	<i>TFD</i>
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9%in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.986
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - November 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
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Molecular weight	mwt	221	g/mol	
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Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
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Vapor Pressure	vapr	3.41E-5	torr	
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Solubility	sol	6100	mg/L	
------------	-----	------	------	--

Kd	Kd		mg/L	
----	----	--	------	--

Koc	Koc	13.4	mg/L	
-----	-----	------	------	--

Photolysis half-life	kdp	105	days	Half-life
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Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
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Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
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Aerobic Soil Metabolism	asm	18	days	Halfife
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Hydrolysis:	pH 5	0	days	Half-life
-------------	------	---	------	-----------

Hydrolysis:	pH 7	0	days	Half-life
-------------	------	---	------	-----------

Hydrolysis:	pH 9	0	days	Half-life
-------------	------	---	------	-----------

Method:	CAM	2	integer	See PRZM manual
---------	-----	---	---------	-----------------

Incorporation Depth:	DEP1		cm	
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Application Rate:	TAPP	1.12	kg/ha	
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Application Efficiency:	APPEFF	0.99	fraction	
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Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
-------------	------	------	--	--

Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm	
------------------	------	-------	-----------------------------------	--

Interval 1 interval	3	days	Set to 0 or delete line for single app.	
---------------------	---	------	---	--

app. rate 1 apprate	0.56	kg/ha		
---------------------	------	-------	--	--

Interval 2 interval	3	days	Set to 0 or delete line for single app.	
---------------------	---	------	---	--

app. rate 2 apprate	0.56	kg/ha		
---------------------	------	-------	--	--

Record 17: FILTERA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run	IR	EPA Pond
-------------------------	----	----------

Flag for runoff calc.	RUNOFF none	none, monthly or total(average of entire run)
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Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214
0.1	2.3788	2.2615	1.958	1.5565	1.3295	0.69082
Average of yearly averages:						0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility sol	2112	mg/L			
Kd Kd		mg/L			
Koc Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life	
Aerobic Aquatic Metabolism		kbacw	49.2	days	Halfife
Anaerobic Aquatic Metabolism		kbacs	0	days	Halfife
Aerobic Soil Metabolism		asm	24.6	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life	
Hydrolysis:	pH 7	0	days	Half-life	
Hydrolysis:	pH 9	0	days	Half-life	
Method: CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEPI		cm		
Application Rate:	TAPP	0.18	kg/ha		
Application Efficiency:		APPEFF	1.0	fraction	
Spray Drift	DRFT	0	fraction of application rate applied to pond		
Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm		
Interval 1 interval	3	days	Set to 0 or delete line for single app.		
app. rate 1 apprate	0.09	kg/ha			
Interval 2 interval	3	days	Set to 0 or delete line for single app.		
app. rate 2 apprate	0.09	kg/ha			
Record 17: FILTRA					
IPSCND	1				
UPTKF					
Record 18: PLVKRT					
PLDKRT					
FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond		
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)		

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients								
NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.

Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.

Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .

Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.



Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

A handwritten signature in black ink is written over a horizontal line. The signature is cursive and appears to read "Jack E. Housenger".

Jack E. Housenger, Director
Office of Pesticide Programs

Date: _____

A handwritten date "11/9/16" is written in black ink over a horizontal line.

Summary

This document announces that the U.S. Environmental Protection Agency (the EPA or the agency) has granted a conditional registration under Section 3(c)(7)(B) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba for use on genetically-engineered (GE) cotton and GE soybean that have been engineered to be resistant to dicamba in the following states: Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

These new dicamba uses were originally proposed by the Monsanto Company to be added to the currently registered herbicide product M1691 (the EPA Registration Number 524-582). This is the specific formulation that was listed in the agency's Proposed Decision released for public comment earlier this year. Since the proposed decision was published, the agency also assessed a lower volatility dicamba formulation (M1768, with the brand name Xtendimax™ with VaporGrip™ Technology, the EPA Registration Number 524-617). the EPA expects the lower volatility formulation to further reduce the potential off site movement of generic dicamba formulations and is included in today's regulatory decision.

The M1768 product contains the same active ingredient as M1691, diglycolamine (DGA) salt of dicamba, and is to be used with equivalent application rates and the same application techniques. Because the two products contain the same active ingredient used at the same rates with the same methods, all of the environmental and human health assessments completed and made public in connection with the proposed registration decision for the M1691 apply to M1768. After assessing volatility studies conducted on the M1768 formulation (discussed later in this document), the EPA has determined that the new lower volatility formulation of M1768 offers the user a product with less potential to volatilize and move off the target area. The volatility analysis is included in the docket for this final decision. Therefore, the new uses were granted for the M1768 formulation.

This final decision document discusses several agency considerations of the new uses for dicamba on GE soybean and GE cotton, including discussions of human health and environmental risks associated with the new uses as well as the benefits associated with these uses. the EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the assessment for human health included the N, N-Bis-(3-aminopropyl) methylamine (BAPMA) salt of dicamba (M1768 contains the DGA salt of dicamba) because the data on the BAPMA salt was relevant to the analysis and presented the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. But, when product specific considerations were necessary for the analysis, the EPA reviewed the effects of the DGA salt. For example, to determine appropriate spray drift buffers, the agency examined drift potential using studies conducted on the DGA salt formulation.

Under the Plant Protection Act, the United States Department of Agriculture (USDA) deregulated the GE cotton and GE soybean seeds tolerant to dicamba on January 15, 2015.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Product: M1768 Herbicide (Xtendimax™ with VaporGrip™ Technology) EPA Registration Number 524-617

Background

On April 28, 2010 and July 30, 2012, respectively, the EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on GE soybean and GE cotton. The application also requested the establishment of new tolerances for residues resulting from the new uses. The tolerances for these new uses have been established.

Dicamba is an active ingredient that is currently used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The new uses will expand the current timing of dicamba applications to post-emergence (over-the-top) applications to GE cotton and GE soybean crops. Until this registration, dicamba was only registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. It is important to note that using registered dicamba products on GE cotton or GE soybean crops that are not registered specifically for post-emergence use on GE cotton or GE soybean crops is inconsistent with the pesticide's labeling and a violation of FIFRA.

New Uses

Cotton

Dicamba products that are currently registered on conventional cotton are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.25 to 1.0 pounds acid equivalent (lb a.e.) dicamba per acre. The maximum annual application for all preplant, at planting and pre-emergence applications combined on conventional cotton is 1.0 lb a.e. dicamba per acre per season.

For the new use, for post-emergence (in-crop) application of dicamba for use on GE cotton, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total of all in-crop applications for GE cotton is 88 fluid ounces (2.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, and pre-emergence treatments to GE cotton, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, and pre-emergence applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications (preplant, at-planting, pre-emergence and post-emergence (in-crop) must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. For example, if a preplant application of 44 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for GE cotton.

The minimum retreatment interval is 7 days; the pre-harvest interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

Dicamba products that are currently registered on conventional soybeans are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.125 to 0.5 pounds acid equivalent (lb a.e.) dicamba per acre and for preharvest burndown treatments at 0.25 to 1.0 lb a.e. dicamba per acre. The maximum annual application for all preplant, at planting, pre-emergence, and preharvest burndown applications combined on conventional soybeans is 1.0 lb a.e. dicamba per acre per season.

For the new use for post-emergence (in-crop) application of this product to GE soybeans, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total for all in-crop applications for GE soybeans is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, pre-emergence, and preharvest burndown treatments to GE soybeans, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, pre-emergence, and preharvest applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay, is 14 days (R1 Growth stage).

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human

health risk assessment for dicamba, risks were assessed in a manner that protects human health from exposure to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data show greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, the EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. The EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, the EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the agency assumes that any amount of exposure will lead to some degree of risk. Thus, the agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be "not likely" to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles the EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2)

- more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. Since the BAPMA salt shows increased toxicity via inhalation, the BAPMA was included in the aggregate risk assessment. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment for these new uses. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The agency determined, based on review of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, the EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, the EPA assumes that any amount of exposure will lead to some degree of risk. Thus, the EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity

study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainly factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and as discussed in Section C below, 1X for FQPA SF when applicable). The inhalation HEC results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined, and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite lacked findings of carcinogenicity in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

The EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) There is no evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (i) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (ii) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (iii) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerance levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2- generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models (e.g., models using screening level assumptions). Therefore, the agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

The EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other

substances. Therefore, the EPA finds for this decision that dicamba does not have a common mechanism of toxicity with other substances. For information regarding the EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by the EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on the EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities. Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with the EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the POD for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and new uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the agency's LOC for both food and water. For the U.S. population, the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting

residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being established for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to the agency's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

Since dicamba products registered for use on residential turf come in both liquid and granular

formulations, both are accounted for in this assessment. The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application Inhalation Exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the new uses of dicamba on GE corn and GE soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. In general, volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40-acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Although a more recent volatility study conducted using the M1768 formulation was submitted and reviewed, which demonstrated comparable potential for volatility as described in greater detail in the document entitled *Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton* available in the docket for this action, that study was not available at the time this Human Health assessment was developed. Results of PERFUM modeling using the Bradenton, FL study however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates for potential human bystander exposure are not of concern.

4. Spray Drift

Without considering mitigation measures, it is reasonable to assume that spray drift may be a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The maximum single application rate of dicamba for this new use is 1 lb a.e./A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. This spray drift fraction estimation differs from that used for environmental exposures because, unlike environmental risk assessment that uses estimations to determine exposures at the edge of the treated field, estimations for human health risk assessment are used to assess the average deposition over a wide area of lawn. For the purposes of the new uses on dicamba, this is considered a screening level assumption since the new use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate of 1 lb a.e./A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the Federal Food, Drug, and Cosmetic Act (FFDCA), the EPA must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be

aggregated. When aggregating exposures and risks from various sources, the EPA considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- or long-term durations via the oral, dermal, or inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and new use sites. Drinking water values were incorporated directly into the assessment. The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term Aggregate Risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short-term aggregate risks.

c. Long-term Aggregate Risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant percent crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

6. Occupational Risk Assessment

a. Short- and Intermediate-term Handler Risk

The EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on GE cotton and GE soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short- and Intermediate-term Post-application Risk

The EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard via the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation Post Application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on GE soybean and GE cotton is provided below. More detailed discussions can be found in the agency documents titled:

- *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708) and*
- *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701), and its addendums entitled,*
- *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean and*
- *Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean and*
- *M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide, EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton.*

These documents are in docket number EPA-HQ-OPP-2016-0187, available at [regulation.gov](http://www.regulation.gov). A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would

likely persist; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for GE soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. Without considering mitigation measures on the product label, possible pathways for reaching surface water include field/site runoff, spray drift during application, and vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. Without considering mitigation measures, the major route of exposure to non-target organisms is likely spray drift and runoff. While multiple literature studies show that there is potential for high vapor drift for certain dicamba salts and formulations from soybean fields resulting in non-target plant injury, the available dicamba M1768 formulation volatility research the agency has reviewed indicates that non-target plant biomass and yield will not be affected by use of the M1768 formulation. The assessments, which can be found in the docket for this action, related to these routes of exposure are described in the sections below.

3. Runoff

The agency considered the potential effects due to runoff and developed mitigation to limit off-site runoff that is reflected in the approved labeling for these new uses (e.g., Do not make application of this product if rain is expected in the next 24 hours.). A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

Without consideration of mitigation measures on the approved label, the agency considers spray drift exposure to be the principal risk issue to be considered with these new uses, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following applications of currently registered dicamba products (not containing the same labeling restrictions), likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). The EPA determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. The approved labeling for this action contains these restrictions. Based on the weight of evidence approach, the EPA also determined that labels must include language to maintain an in-field buffer (downwind at the time of application) of 110 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (i.e., NOAEC for soybean plant height). The approved labeling for this action includes these restrictions.

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, and at the time the EPA proposed these new uses, the agency had concerns regarding the volatility of dicamba and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with an additional submission post-proposal that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Based on field volatility (flux) studies (conducted in accordance with the label conditions such as nozzle and ground speed limitations) and laboratory vapor-phase toxicity and exposure (humidome) studies, the 110-foot omnidirectional buffer for volatilization is no longer warranted for the dicamba DGA plus VaporGrip™ (M1768) formulation, because the expected exposure at field's edge is less than the NOAEC for plant risk.

The EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints (plant height and yield) are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (i.e., plant height) for the most sensitive plant species tested (i.e., soybeans), the EPA uses field studies and modeling to determine the distance from site of application to where the NOAEC is not expected to be exceeded. It is further noted that the labels for the new uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and

chronic ($RQ = \text{Exposure}/\text{Toxicity}$). RQs are then compared to the EPA's levels of concern (LOCs). The LOCs are criteria used by the agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOAEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including conventional cotton and soybean. The new uses on GE soybeans and GE cotton expand the timing of applications from only pre-emergence and pre-harvest for soybeans and only pre-emergence and post-harvest for cotton to allowing post-emergence over-the-top applications on these GE crops. The maximum yearly application rates would remain 2.0 lb a.e./A for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./A between pre-emergence and post-emergence applications.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening - level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations at the species-specific level.

The results of the screening-level risk assessments indicate that the RQs do not exceed the agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the agency's LOC. The screening-level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both GE cotton and GE soybeans, based on the new maximum application rates, the screening-

level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, the potential for ecological concerns is related to the potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in GE soybeans. Before considering mitigation measures, the EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening-level assessment, further refinement, as discussed below, suggest that risks are lower and confined to the treated field under the mitigations imposed on the registration. Risks above the level of concern remain for terrestrial plants and animals on the treated field; comparison of the risk to benefits associated with the new use are described in Section VIII.

1. Risk to Birds

For birds, the screening-level assessment (which assumed that 100% of diet is from the treated field) indicated that the RQs exceeded the agency's LOCs on an acute basis for both GE soybean and GE cotton. More specifically, the screening-level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in GE soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming GE soybean forage/hay.

The agency's screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in GE soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs. Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns. This suggests that dicamba consumed in the diet may be less available than assumed using dose-based exposures. Expected field exposure is more likely to be accounted for by the dietary studies that did not indicate risk exceeding levels of concern rather than the acute oral dose studies where risk exceeding thresholds of concern was indicated. As mentioned above, the screening-level analysis assumes that 100% of the diet comes from the treated field which may overestimate total dicamba ingestion.

Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger

concerns for many food items. In addition, estimates of exposure in screening-level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening-level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms that are off the treated field. With this last line of evidence in mind, the pesticide label requires an in-field 110 to 220-foot downwind buffer to eliminate off-site exposure above threshold levels that would trigger risk concern for birds (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for birds feeding on GE plants on the field, and are not expected off the field (since DCSA formation is only a result of dicamba tolerant-plant metabolism).

2.Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the agency’s LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening-level assessment using the maximum exposure values from empirical datasets for DCSA residues in GE soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. The screening-level assessment using the maximum exposure values from empirical data for DCSA residues in GE cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The agency’s screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in GE soybeans and GE cotton plants to determine the RQ values. The EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas. As described in the section for risk to birds, the screening-level assessment assumes that 100% of the diet comes from the treated field.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the pesticide label requires an in-field 110 to 220-foot downwind buffer eliminate off-site exposure above threshold levels that would trigger risk concern for mammals (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for mammals feeding on GE plants on the field, and are not expected off the field.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the new uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift (without mitigation measures), and for dicots in semi-aquatic areas due to runoff and spray drift (without mitigation measures). The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that the approved labeling restrictions will keep the product on the field, thereby reducing spray drift off field. These determinations were made after reviewing additional registrant submitted studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and a change in the formulation to be registered. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1768 Herbicide when an in-field 110 to 220-foot downwind buffer is incorporated between the application equipment and the edges of the treated field. Therefore, potential risks to plants from spray drift is mitigated by requiring a 110-220 foot (depending on application rate) buffer downwind at the time of application.

4. Synergism

The agency views synergism to be a rare event and intends to follow the National Research Council's recommendation for government agencies to proceed with estimating effects of pesticide mixtures with the assumption that the components have additive effects¹ in the absence of any data to support the hypothesis of a synergistic interaction between pesticide active ingredients. However, data is being cited in connection with patent claims submitted to the U.S. Patent and Trademark Office (USPTO) for claims of synergism for specific combinations of dicamba with other herbicides.

The EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings with the USPTO where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. The endpoints in these patent application studies were based on visual observations of weed control and injury, and so were not directly applicable to the EPA's quantitative risk assessment process for plants, in which measures of sub-lethal effects (plant height and weight) serve as sensitive effects thresholds for risk estimation purposes. The EPA believes this quantitative

¹ The phrase 'additive effects' is used when the effect of the combination of chemicals can be estimated directly from the sum of the scaled exposure levels (dose addition) or of the responses (response addition) of the individual components.

approach is very reliable for the purpose of potential toxicity to plants.

The agency is continuing its work with that information in order to better understand the scope of these uncertainties for these specific combinations and to develop an approach that best manages the potential risks while still maintaining the important benefits derived from tank mixing. While evaluation of these data are still in progress, the agency is requiring that the end-use product label allow only tank mixing with other herbicides in combinations that have not been granted patents for synergistic behavior at the time of this registration. For prohibited combinations, if the EPA determines that sufficient data do not exist to support synergistic effects with a particular active ingredient, or if the agency has evaluated data that is more directly applicable to the agency's quantitative risk assessment process for plants that demonstrates that no increased toxicity to plants exists and are therefore not of concern, that ingredient may then be allowed in tank mix combinations. A list of acceptable tank mixes will be maintained by Monsanto on their already established website, www.xtendimaxapplicationrequirements.com

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this final decision.

In the screening-level risk assessment performed for the new application timing of dicamba (DGA) on GE cotton and GE soybean to be resistant to dicamba, the EPA determined that levels of concern were not exceeded for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degrade from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on GE seeds to be resistant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at [species/ecological-risk-assessment-process-under-endangered-species-act](http://www.epa.gov/species/ecological-risk-assessment-process-under-endangered-species-act)]. That assessment uses broad default assumptions to establish estimated

environmental concentrations of particular pesticides. If the screening-level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, the EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. The EPA determines that there is “no effect” on listed species if, at any step in the screening-level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening-level assessment, a pesticide still exceeds the agency’s levels of concern for listed species, the EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening-level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening-level risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to the EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening-level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a No Effect determination is identified for the corresponding taxon.

This registration for dicamba has been finalized for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an acceptable assessment of listed species is completed for any such state.

Based on the EPA’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), the EPA identified the listed species that are inside the “action area” (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 34 states.

The following criteria are used to make a species-specific effects determination:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY EFFECT categories depending upon their specific biological needs and circumstances of exposure.
- Those that fall under the MAY EFFECT category are found to be either LIKELY or NOT LIKELY TO ADVERSELY AFFECT the listed species.
A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial
- A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift label mitigation language including an in-field spray drift buffer of 110 feet (for the 0.5 lb/A rate) and 220 feet (for the 1.0 lb/A rate) downwind at the time of application is expected to limit off site transport of dicamba DGA through spray drift. Therefore, the EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, the EPA concluded a NO EFFECT determination for all but 24 species originally identified as potentially at-risk (in the screening-level assessment) because they are not expected to occur on cotton and soybean fields.

The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in the EPA's refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, the EPA made a determination that exposure occurring on the field would have "may affects" (either "unlikely to adversely affect" or "likely to adversely affect" on 3 species (the Eskimo Curlew, the Spring Creek Bladderpod in Wilson county, TN, and the Audubon Crested Caracara in Palm Beach county, FL) within the States covered by this final decision. The EPA initiated informal consultation with the U.S. Fish and Wildlife Service (FWS) for the Eskimo curlew. The FWS concurred with the "unlikely to adversely affect" determination and no further action need be taken relative to this species. Furthermore, to address the remaining effects, the registrant submitted revised labeling and the EPA approved the labeling that prohibits application in both Wilson county, TN and Palm Beach county, FL. Therefore, the EPA makes no effect determinations for all listed species that are expected to be on the treated fields.

Additionally, the agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, the EPA's analysis also supports a no effects determination for runoff exposure for off-field listed plants for the new labeled use of dicamba DGA. To further protect species off the treated field against runoff, rainfast mitigation is required on the label ("Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.").

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on GE crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, the EPA is requiring, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a lack of performance can obtain direct support from Monsanto through a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, the EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the new uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and

contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers' permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to the EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15, 2018, on or before January 15th of each year thereafter, Monsanto must submit annual summary reports to the EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the final dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for the EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The agency received 21,710 comments in response to the public participation process (Docket ID: the EPA-HQ-OPP-2016-0187) regarding the EPA's proposed decision for the application to register the use of dicamba on GE cotton and GE soybeans. Comments received were both in favor of and opposed to the decision to register the new uses which will provide growers with additional tools to control broadleaf weeds. The EPA welcomes input from the public during the decision process when registering significant new uses, and is committed to reviewing the comments received and determining whether changes or further mitigation are necessary to meet the applicable statutory standards. The EPA reviewed and evaluated the comments received during the comment period before issuing this final regulatory decision. Since many of the comments covered similar concerns, the comments were grouped into major topic areas. Please see *Response to Public Comments Received Regarding the New Use of Dicamba on Dicamba-Tolerant Cotton and Soybeans* dated November 7, 2016 for the agency's response to these comments.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest

management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Previously registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the previously registered uses of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba will expand weed management options on GE cotton and GE soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season will target new flushes of weeds, thereby reducing populations of these weeds and particularly will help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Registration Decision

In accordance with FIFRA, the EPA only registers a pesticide when it finds that the use will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, the EPA is charged with balancing the uncertainties and risks posed by a pesticide against the benefits associated with the use of the pesticide. The EPA must determine if the benefits in light of its use outweigh the risks in order for the agency to register a pesticide.

In the case for the new uses of dicamba on GE soybeans and GE cotton, and in consideration of all best available data and assessment methods, the EPA determines that its decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered complete and adequate to evaluate risks to infants and children. The agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some LOCs were exceeded for certain birds, reptiles, amphibians, and mammals that may be in the treated fields. These assessments included conservative risk estimates using screening-level (worst case) assumptions that are unlikely to apply to the majority of the birds, reptiles, amphibians, and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated field. Because of these additional restrictions, the EPA expects these uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the agency's levels of concern.

On the benefits side of the analysis, use of dicamba on GE soybeans and GE cotton is expected to become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed

and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of the United States soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states in the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on GE soybeans and GE cotton is beneficial as it provides an effective tool to treat especially noxious weeds, such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba can help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to GE soybean and GE cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the approved labeling restrictions will include further beneficial protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

The EPA finds these benefits important. Furthermore, this regulatory decision includes a number of requirements that are expected to effectively limit concerns for off field risk. This registration action is only for a product confirmed by data to be a lower volatility formulation. In addition, the label requires very specific and rigorous drift mitigation measures, including in-field buffers, aerial application prohibitions, boom height requirements, specific nozzle and spray pressure requirements, and wind and tractor speed limitations. These mitigations are known to profoundly impact any drift potential from pesticide application. In aggregate, these formulations and labeling requirements are expected to eliminate any offsite exposures and effectively prevent risk potential to people and non-target species.

After weighing all the risks of concern against the benefits of the new uses, the EPA finds that when the mitigation measures for these uses are applied, the benefits of the use of the pesticide outweighs any remaining minimal risks, if they exist at all. Therefore, registering these new uses will not generally cause unreasonable adverse effects on human health or the environment. the EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(7)(B) registration finding for the new uses. Although the EPA proposed registering dicamba under FIFRA section 3(c)(5), new data requirements have been identified through registration review that will be applicable to all dicamba products (and all uses), therefore the agency is registering these new uses under FIFRA section 3(c)(7)(B).

A. Data Requirements

Although there are currently no outstanding data require to support the final registration of this action, the EPA has identified data that will be required in connection with Registration Review activities for dicamba. Those requirements will be applicable to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the final supplemental labels unless otherwise noted below.

1. Worker Protection

(Although the following Worker Protection labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on May 1, 2014 for this product.)

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. Environmental Hazards

(Although the following Environmental Hazards labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on September 18, 2013 for this product.)

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1768 Herbicide for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call 1-844-RRXTEND.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season,
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use only Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying XtendiMax™ With VaporGrip™ Technology or any other approved nozzle found at www.xtendimaxapplicationrequirements.com. Do not use any other nozzle and pressure combination not specifically listed on this website. www.xtendimaxapplicationrequirements.com

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity or temperatures above 91 degrees Fahrenheit, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and can be impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Do not apply this product during a temperature inversion. Off-target movement potential can be high during a temperature inversion. During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on evenings and nights with limited cloud cover and light to no wind. Cooling of air at the earth's surface takes place and warmer air is trapped above it. They can begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing. The inversion will often dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

Buffer

Maintain a 110 foot downwind buffer (when applying 22 fluid ounces of this product per acre) or a 220 foot downwind buffer (when applying 44 fluid ounces of this product per acre) between the last treated row and the closest downwind edge (in the direction in which the wind is blowing). If any of the following areas below are directly adjacent to the treated field, the areas listed below can be considered part of the buffer distance.

To maintain this required buffer zone:

- No application swath can be initiated in, or into an area that is within the applicable buffer distance.

The following areas may be included in the buffer distance calculation when adjacent to field edges:

- Roads, paved or gravel surfaces.
- Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, sorghum, proso millet, small grains and sugarcane. If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant and not conventional cotton and/or soybeans.
- Agricultural fields that have been prepared for planting.
- Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1768 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1768 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.
- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans per year.
- The combined total application rate from crop emergence up to 7 days' pre-harvest must not exceed 88 fluid ounce (2.0lb a.e dicamba) per acre for cotton per year.
- All applications for both cotton and soybeans must not exceed 88 fluid ounces (2.0 lb a.e dicamba) per acre per year.

C. Registration Terms

The EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. The EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. The EPA is basing the final registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., "Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations," *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

The EPA is issuing this registration with a term that requires Monsanto to have an Herbicide Resistance Management (HRM) Plan for M1768 Herbicide. The HRM Plan will focus on educating growers on the appropriate use of the M1768 Herbicide and the associated dicamba-tolerant seeds. The EPA is requiring that the HRM plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

The EPA is requiring that Monsanto or its representative investigate reports of lack of herbicide efficacy as reported by users following "scouting." When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for

“likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures. Additionally, Monsanto must routinely collect plant material for further testing.

c. Annual Reporting of Herbicide Resistance to the EPA

Monsanto must submit annual summary reports to the EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

D. Registration Expiration

The issue of weed resistance is an extremely important issue to keep under control and can be very fast moving. Also, the EPA is aware of reports of off-site incidents potentially due to the illegal use of dicamba products that do not employ the lower volatility formulation of dicamba DGA plus VaporGrip™ (M-1768) on GE cotton and GE soybean. Although the EPA finds that herbicide resistance is adequately addressed by the required herbicide resistance plan and does not expect off-site incidents to occur due to the specific measures required (described above) to this registration, the agency is requiring expiration dates that will ensure that the EPA retains the ability to easily modify the registration or allow the registration to terminate if necessary.

Specifically, this registration automatically expires on November 9, 2018, unless the EPA determines before that date that off-site incidents are not occurring at unacceptable frequencies or levels. If this automatic expiration date is amended (in whatever way the EPA determines is appropriate at the time), it shall not be amended to a date later than November 9, 2021, by which date this registration will automatically expire unless the EPA determines before that date that

herbicide resistance to dicamba is not occurring at unacceptable frequencies or levels, and that off-site incidents are not occurring at unacceptable frequencies or levels.

E. Geographic Limitation on Use of Dicamba M1768 Herbicide

The EPA is issuing these new uses only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62. <http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>



Office of the Clerk
United States Court of Appeals for the Ninth Circuit
Post Office Box 193939
San Francisco, California 94119-3939
415-355-8000

Molly C. Dwyer
Clerk of Court

January 20, 2017

No.: 17-70196
Short Title: National Family Farm Coalition, et al v. USEPA, et al

Dear Petitioners/Counsel

Your Petition for Review has been received in the Clerk's office of the United States Court of Appeals for the Ninth Circuit. The U.S. Court of Appeals docket number shown above has been assigned to this case. You must indicate this Court of Appeals docket number whenever you communicate with this court regarding this case.

The due dates for filing the parties' briefs and otherwise perfecting the petition have been set by the enclosed "Time Schedule Order," pursuant to applicable FRAP rules. These dates can be extended only by court order. Failure of the petitioner to comply with the time schedule order will result in automatic dismissal of the petition. 9th Cir. R. 42-1.

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

FILED

JAN 20 2017

MOLLY C. DWYER, CLERK
U.S. COURT OF APPEALS

NATIONAL FAMILY FARM
COALITION; CENTER FOR FOOD
SAFETY; CENTER FOR
BIOLOGICAL DIVERSITY;
PESTICIDE ACTION NETWORK
NORTH AMERICA,

Petitioners,

v.

U.S. ENVIRONMENTAL
PROTECTION AGENCY; GINA
MCCARTHY, in her official capacity as
Administrator,

Respondents.

No. 17-70196

EPA No.
Environmental Protection Agency

TIME SCHEDULE ORDER

The parties shall meet the following time schedule.

- | | |
|-------------------------------|---|
| Mon., January 30, 2017 | Mediation Questionnaire due. If your registration for Appellate ECF is confirmed after this date, the Mediation Questionnaire is due within one day of receiving the email from PACER confirming your registration. |
| Mon., April 10, 2017 | Petitioners' opening brief and excerpts of record shall be served and filed pursuant to FRAP 32 and 9th Cir. R. 32-1. |

Wed., May 10, 2017

Respondents' answering brief and excerpts of record shall be served and filed pursuant to FRAP 32 and 9th Cir. R. 32-1.

The optional petitioners' reply brief shall be filed and served within fourteen days of service of the respondents' brief, pursuant to FRAP 32 and 9th Cir. R. 32-1.

Failure of the petitioners to comply with the Time Schedule Order will result in automatic dismissal of the appeal. See 9th Cir. R. 42-1.

FOR THE COURT:

MOLLY C. DWYER
CLERK OF COURT

By: Wendy Lam
Deputy Clerk
Ninth Circuit Rule 27-7



United States Court of Appeals
for the Ninth Circuit

P.O. Box 31478
Billings, Montana 59107-1478

CHAMBERS OF
SIDNEY R. THOMAS
CHIEF JUDGE

December 1, 2014

TEL: (406) 373-3200
FAX: (406) 373-3250

Dear Counsel:

I want to take this opportunity to introduce you to the Court's mediation program. The court offers you and your clients professional mediation services, at no cost, to help resolve disputes quickly and efficiently and to explore the development of more satisfactory results than can be achieved from continued litigation. Each year the mediators facilitate the resolution of hundreds of cases, from the most basic contract and tort actions to the most complex cases involving multiple parties, numerous pieces of litigation and important issues of public policy.

The eight circuit mediators, all of whom work exclusively for the court, are highly experienced attorneys from a variety of practices; all have extensive training and experience in negotiation, appellate mediation, and Ninth Circuit practice and procedure. Although the mediators are court employees, the Court has adopted strict confidentiality rules and practices to ensure that what goes on in mediation stays in mediation. *See* Circuit Rule 33-1.

The first step in the mediation process is case selection. To assist the mediators in the case selection process, appellants/petitioners must file a completed Mediation Questionnaire within 7 days of the docketing of the case. *See* Circuit Rules 3-4, and 15-2. Appellees may also fill out and file a questionnaire. The questionnaire with filing instructions accompanies this letter and is also available at www.ca9.uscourts.gov/mediation/forms.php. All counsel are also invited to submit, by e-mail to ca09_mediation@ca9.uscourts.gov, additional, confidential information that might assist the mediators in the case selection process.

Page 2

In most cases, the mediator will schedule a settlement assessment conference, with counsel only, to determine whether the case is suitable for mediation. Please be assured that participation in the mediation program will not slow down disposition of your appeal. Mediation discussions are not limited to the issues on appeal. The discussions can involve other cases and may include individuals who are not parties to the litigation, if doing so enables the parties to reach a global settlement.

Further information about the mediation program may be found on the court's website: www.ca9.uscourts.gov/mediation/. Please address questions directly to the Mediation Unit at 415-355-7900 or ca09mediation@ca9.uscourts.gov.

Our mediators do a terrific job. I hope you'll give them the opportunity to work on your case.

Sincerely,

A handwritten signature in cursive script that reads "Sidney R. Thomas".

Sidney R. Thomas
Chief Circuit Judge

UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

Circuit Mediation Office

Phone (415) 355-7900 Fax (415) 355-8566

<http://www.ca9.uscourts.gov/mediation>**MEDIATION QUESTIONNAIRE**

This form is available in a fillable version at http://cdn.ca9.uscourts.gov/datastore/uploads/forms/Mediation_Questionnaire.pdf.

The purpose of this questionnaire is to help the court's mediators provide the best possible mediation service in this case; it serves no other function. Responses to this questionnaire are **not** confidential. Appellants/Petitioners must electronically file this document within 7 days of the docketing of the case. 9th Cir. R. 3-4 and 15-2. Appellees/Respondents may file the questionnaire, but are not required to do so.

9th Circuit Case Number(s):	<input style="width: 100%;" type="text"/>		
District Court/Agency Case Number(s):	<input style="width: 100%;" type="text"/>		
District Court/Agency Location:	<input style="width: 100%;" type="text"/>		
Case Name:	<input style="width: 30%;" type="text"/>	v.	<input style="width: 30%;" type="text"/>
If District Court, docket entry number(s) of order(s) appealed from:	<input style="width: 100%;" type="text"/>		
Name of party/parties submitting this form:	<input style="width: 100%;" type="text"/>		

Briefly describe the dispute that gave rise to this lawsuit.

Briefly describe the result below and the main issues on appeal.

(Continue to next page)

Describe any proceedings remaining below or any related proceedings in other tribunals.

Provide any other thoughts you would like to bring to the attention of the mediator.

*Any party may provide additional information **in confidence** directly to the Circuit Mediation Office at ca09_mediation@ca9.uscourts.gov. Provide the case name and Ninth Circuit case number in your message. Additional information might include level of interest in including this case in the mediation program, the case's settlement history, issues beyond the litigation that the parties might address in a settlement context, or future events that might affect the parties' willingness or ability to mediate the case.*

CERTIFICATION OF COUNSEL

I certify that:

☐ a current service list with telephone and fax numbers and email addresses is attached (see 9th Circuit Rule 3-2).

☐ I understand that failure to provide the Court with a completed form and service list may result in sanctions, including dismissal of the appeal.

Signature

("s/" plus attorney name may be used in lieu of a manual signature on electronically-filed documents.)

Counsel for

How to File: Complete the form and then convert the filled-in form to a static PDF (File > Print > PDF Printer or any PDF Creator). To file, log into Appellate ECF and select File Mediation Questionnaire. (*Use of the Appellate ECF system is mandatory for all attorneys filing in this Court, unless they are granted an exemption from using the system.*)

UNITED STATES COURT OF APPEALS for the NINTH CIRCUIT**Office of the Clerk****After Opening a Case – Counselled Non-Immigration Agency Cases**
(revised April 2016)**Court Address – San Francisco Headquarters**

<i>Mailing Address for U.S. Postal Service</i>	<i>Mailing Address for Overnight Delivery (FedEx, UPS, etc.)</i>	<i>Street Address</i>
Office of the Clerk James R. Browning Courthouse U.S. Court of Appeals P.O. Box 193939 San Francisco, CA 94119-3939	Office of the Clerk James R. Browning Courthouse U.S. Court of Appeals 95 Seventh Street San Francisco, CA 94103-1526	95 Seventh Street San Francisco, CA 94103

Court Addresses – Divisional Courthouses

<i>Pasadena</i>	<i>Portland</i>	<i>Seattle</i>
Richard H. Chambers Courthouse 125 South Grand Avenue Pasadena, CA 91105	The Pioneer Courthouse 700 SW 6th Ave, Ste 110 Portland, OR 97204	William K. Nakamura Courthouse 1010 Fifth Avenue Seattle, WA 98104

Court Website – www.ca9.uscourts.gov

The Court's website contains the Court's Rules and General Orders, information about electronic filing of documents, answers to frequently asked questions, directions to the courthouses, forms necessary to gain admission to the bar of the Court, opinions and memoranda, live streaming of oral arguments, links to practice manuals, and an invitation to join our Pro Bono Program.

Court Phone List

Main Phone Number	(415) 355-8000
Attorney Admissions	(415) 355-7800
Calendar Unit	(415) 355-8190
Docketing	(415) 355-7840
Death Penalty	(415) 355-8197
Electronic Filing – CM/ECF	Submit form at http://www.ca9.uscourts.gov/cmecf/feedback
Library	(415) 355-8650
Mediation Unit	(415) 355-7900
Motions Attorney Unit	(415) 355-8020
Procedural Motions Unit	(415) 355-7860
Records Unit	(415) 355-7820
Divisional Court Offices:	
Pasadena	(626) 229-7250
Portland	(503) 833-5300
Seattle	(206) 224-2200

Electronic Filing - CM/ECF

The Ninth Circuit’s CM/ECF (Case Management/Electronic Case Files) system is mandatory for all attorneys filing in this Court, unless they are granted an exemption. All non-exempted attorneys who appear in an ongoing case are required to register for and to use CM/ECF. Registration and information about CM/ECF is available on the Court’s website at www.ca9.uscourts.gov under *Electronic Filing–CM/ECF*. Read the Circuit Rules, especially Ninth Circuit Rule 25-5, for guidance on filing documents electronically via CM/ECF, and see the CM/ECF User Guide for a complete list of the available types of filing events.

Rules of Practice

The Federal Rules of Appellate Procedure (Fed. R. App. P.), the Ninth Circuit Rules (9th Cir. R.) and the General Orders govern practice before this Court. The rules are available on the Court's website at www.ca9.uscourts.gov under *Rules*.

Practice Resources

The Appellate Lawyer Representatives' Guide to Practice in the United States Court of Appeals for the Ninth Circuit is available on the Court's website www.ca9.uscourts.gov at *Guides and Legal Outlines > Appellate Practice Guide*. The Court provides other resources in *Guides and Legal Outlines*.

Admission to the Bar of the Ninth Circuit

All attorneys practicing before the Court must be admitted to the Bar of the Ninth Circuit. Fed. R. App. P. 46(a); 9th Cir. R. 46-1.1 & 46-1.2.

For instructions on how to apply for bar admission, go to www.ca9.uscourts.gov and click on the *Attorneys* tab > *Attorney Admissions > Instructions*.

Notice of Change of Address

Counsel who are registered for CM/ECF must update their personal information, including street addresses and email addresses, online at: <https://pacer.psc.uscourts.gov/pscuf/login.jsf> 9th Cir. R. 46-3.

Counsel who have been granted an exemption from using CM/ECF must file a written change of address with the Court. 9th Cir. R. 46-3.

Payment of Fees

The \$500.00 filing fee or a motion to proceed in forma pauperis shall accompany the petition. 9th Cir. R. 3-1.

A motion to proceed in forma pauperis must be supported by the affidavit of indigency found at Form 4 of the Federal Rules of Appellate Procedure, available at the Court's website, www.ca9.uscourts.gov, under *Forms*.

Failure to satisfy the fee requirement or to apply to proceed without payment of fees will result in the petition's dismissal. 9th Cir. R. 42-1.

Motions Practice

Following are some of the basic points of motion practice, governed by Fed. R. App. P. 27 and 9th Cir. R. 27-1 through 27-14.

- Neither a notice of motion nor a proposed order is required. Fed. R. App. P. 27(a)(2)(C)(ii), (iii).
- Motions may be supported by an affidavit or declaration. 28 U.S.C. § 1746.
- Each motion should provide the position of the opposing party. Circuit Advisory Committee Note to Rule 27-1(5); 9th Cir. R. 31-2.2(b)(6).
- A response to a motion is due 10 days from the service of the motion. Fed. R. App. P. 27(a)(3)(A); Fed. R. App. P. 26(c). The reply is due 7 days from service of the response. Fed. R. App. P. 27(a)(4); Fed. R. App. P. 26(c).
- A response requesting affirmative relief must include that request in the caption. Fed. R. App. P. 27(a)(3)(B).
- A motion filed after a case has been scheduled for oral argument, has been argued, is under submission or has been decided by a panel, must include on the initial page and/or cover the date of argument, submission or decision and, if known, the names of the judges on the panel. 9th Cir. R. 25-4.

Emergency or Urgent Motions

All emergency and urgent motions must conform with the provisions of 9th Cir. R. 27-3. Note that a motion requesting procedural relief (e.g., an extension of time to file a brief) is *not* the type of matter contemplated by 9th Cir. R. 27-3. Circuit Advisory Committee Note to 27-3(3).

Prior to filing an emergency motion, the moving party *must* contact an attorney in the Motions Unit in San Francisco at (415) 355-8020.

When it is absolutely necessary to notify the Court of an emergency outside of standard office hours, the moving party shall call (415) 355-8000. Keep in mind that this line is for true emergencies that cannot wait until the next business day (e.g., an imminent execution or removal from the United States).

Briefing Schedule

The Court sets the briefing schedule at the time the petition is docketed.

Certain motions (e.g., a motion for dismissal) automatically stay the briefing schedule. 9th Cir. R. 27-11.

The opening and answering brief due dates are not subject to the additional time described in Fed. R. App. P. 26(c). 9th Cir. R. 31-2.1. The early filing of petitioner's opening brief does not advance the due date for respondent's answering brief. *Id.*

Extensions of Time to file a Brief

Streamlined Request

Subject to the conditions described at 9th Cir. R. 31-2.2(a), you may request one streamlined extension of up to 30 days from the brief's existing due date. Submit your request via CM/ECF using the "File Streamlined Request to Extend Time to File Brief" event on or before your brief's existing due date. No form or written motion is required.

Written Extension

Requests for subsequent extensions or extensions of more than 30 days will be granted only upon a written motion supported by a showing of diligence and substantial need. This motion shall be filed at least 7 days before the due date for the brief. The motion shall be accompanied by an affidavit or declaration that includes all of the information listed at 9th Cir. R. 31-2.2(b).

The Court will ordinarily adjust the schedule in response to an initial motion. Circuit Advisory Committee Note to Rule 31-2.2. The Court expects that the brief will be filed within the requested period of time. *Id.*

Contents of Briefs and Record

The required components of a brief are set out at Fed. R. App. P. 28 and 32, and 9th Cir. R. 28-2, 32-1 and 32-2.

The content and filing of the record are governed by Fed. R. App. P. 16(a) and 17. If respondent does not file the record or certified list by the specified date, petitioner may move to amend the briefing schedule.

After the electronically submitted brief has been reviewed, the Clerk will request 7 paper copies of the brief that are identical to the electronic version. 9th Cir. R. 31-1. Do not submit paper copies until directed to do so.

Excerpts of Record

The Court requires Excerpts of Record rather than an Appendix. 9th Cir. R. 30-1.1. Please review 9th Cir. R. 17-1.3 through 17-1.6 to see a list of the specific contents and format. For Excerpts that exceed 75 pages, the first volume must comply with 9th Cir. R. 17-1.6 and 30-1.6(a). Excerpts exceeding 300 pages must be filed in multiple volumes. 9th Cir. R. 30-1.6(a).

Respondent may file supplemental Excerpts, and petitioner may file further Excerpts. 9th Cir. R. 17-1.7; 17-1.8; 30-1.7 and 30-1.8. If you are a respondent responding to a pro se brief that did not come with Excerpts, then your Excerpts need only include the contents set out at 9th Cir. R. 30-1.7.

Excerpts must be submitted in PDF format in CM/ECF on the same day the filer submits the brief. The filer shall serve a paper copy of the Excerpts on any party not registered for CM/ECF.

If the Excerpts contain sealed materials, you must submit the sealed documents electronically in a separate volume in a separate transaction from the unsealed volumes, along with a motion to file under seal. 9th Cir. R. 27-13(e). Sealed filings must be served on all parties by mail, or if mutually agreed by email, rather than through CM/ECF noticing.

After electronic submission, the Court will direct the filer to file 4 separately-bound paper copies of the excerpts of record with white covers.

Mediation Program

Mediation Questionnaires are required in all counseled agency cases except those cases seeking review of a Board of Immigration Appeals decision. 9th Cir. R.

15-2.

The Mediation Questionnaire is available on the Court's website at www.ca9.uscourts.gov under *Forms*. The Mediation Questionnaire should be filed within 7 days of the docketing of the petition. The Mediation Questionnaire is used only to assess settlement potential.

If you are interested in requesting a conference with a mediator, you may call the Mediation Unit at (415) 355-7900, email ca09_mediation@ca9.uscourts.gov or make a written request to the Chief Circuit Mediator. You may request conferences confidentially. More information about the Court's mediation program is available at <http://www.ca9.uscourts.gov/mediation>.

Oral Hearings

Approximately 14 weeks before a case is set for oral hearing, the parties are notified of the hearing dates and locations and are afforded 3 days from the date of those notices to inform the Court of any conflicts. Notices of the actual calendars are then distributed approximately 10 weeks before the hearing date.

The Court will change the date or location of an oral hearing only for good cause, and requests to continue a hearing filed within 14 days of the hearing will be granted only upon a showing of exceptional circumstances. 9th Cir. R. 34-2.

Oral hearing will be conducted in all cases unless all members of the panel agree that the decisional process would not be significantly aided by oral argument. Fed. R. App. P. 34(a)(2).

Oral arguments are live streamed to YouTube and can be accessed on the Court's website.

Ninth Circuit Appellate Lawyer Representatives APPELLATE MENTORING PROGRAM

1. Purpose

The Appellate Mentoring Program is intended to provide mentoring on a voluntary basis to attorneys who are new to federal appellate practice or would benefit from guidance at the appellate level. In addition to general assistance regarding federal appellate practice, the project will provide special focus on two substantive areas of practice - immigration law and habeas corpus petitions. Mentors will be volunteers who have experience in immigration, habeas corpus, and/or appellate practice in general. The project is limited to counseled cases.

2. Coordination, recruitment of volunteer attorneys, disseminating information about the program, and requests for mentoring

Current or former Appellate Lawyer Representatives (ALRs) will serve as coordinators for the Appellate Mentoring Program. The coordinators will recruit volunteer attorneys with appellate expertise, particularly in the project's areas of focus, and will maintain a list of those volunteers. The coordinators will ask the volunteer attorneys to describe their particular strengths in terms of mentoring experience, substantive expertise, and appellate experience, and will maintain a record of this information as well.

The Court will include information about the Appellate Mentoring Program in the case opening materials sent to counsel and will post information about it on the Court's website. Where appropriate in specific cases, the Court may also suggest that counsel seek mentoring on a voluntary basis.

Counsel who desire mentoring should contact the court at mentoring@ca9.uscourts.gov, and staff will notify the program coordinators. The coordinators will match the counsel seeking mentoring with a mentor, taking into account the mentor's particular strengths.

3. The mentoring process

The extent of the mentor's guidance may vary depending on the nature of the case, the mentee's needs, and the mentor's availability. In general, the mentee should initiate contact with the mentor, and the mentee and mentor should determine together how best to proceed. For example, the areas of guidance may range from

basic questions about the mechanics of perfecting an appeal to more sophisticated matters such as effective research, how to access available resources, identification of issues, strategy, appellate motion practice, and feedback on writing.

4. Responsibility/liability statement

The mentee is solely responsible for handling the appeal and any other aspects of the client's case, including all decisions on whether to present an issue, how to present it in briefing and at oral argument, and how to counsel the client. By participating in the program, the mentee agrees that the mentor shall not be liable for any suggestions made. In all events, the mentee is deemed to waive and is estopped from asserting any claim for legal malpractice against the mentor.

The mentor's role is to provide guidance and feedback to the mentee. The mentor will not enter an appearance in the case and is not responsible for handling the case, including determining which issues to raise and how to present them and ensuring that the client is notified of proceedings in the case and receives appropriate counsel. The mentor accepts no professional liability for any advice given.

5. Confidentiality statement

The mentee alone will have contact with the client, and the mentee must maintain client confidences, as appropriate, with respect to non-public information.

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

NATIONAL FAMILY FARM
COALITION, CENTER FOR FOOD
SAFETY, CENTER FOR
BIOLOGICAL DIVERSITY, and
PESTICIDE ACTION NETWORK
NORTH AMERICA,

Petitioners,

v.

UNITED STATES
ENVIRONMENTAL PROTECTION
AGENCY, and GINA MCCARTHY,
in her official capacity as
Administrator,

Respondents.

Case No.

PETITION FOR REVIEW

and

**CORPORATE DISCLOSURE
STATEMENT**

PETITION FOR REVIEW

Pursuant to Section 16(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. § 136n(b), and Rule 15(a) of the Federal Rules of Appellate Procedure, Petitioners National Family Farm Coalition, Center for Food Safety, Center for Biological Diversity, and Pesticide Action Network North America (collectively Petitioners) hereby petition this Court to review the final order of the United States Environmental Protection Agency (EPA) granting a

conditional registration for the new uses of the herbicide dicamba for use on genetically engineered cotton and soybean that have been engineered to resist dicamba in thirty-four states. Petitioners respectfully petition this Court to find that (1) EPA violated its duties under FIFRA in issuing the conditional registration, and (2) EPA violated the Agency's duties under the Endangered Species Act (ESA), 16 U.S.C. §§ 1533-44, by failing to consult with the United States Fish and Wildlife Service or the National Marine Fisheries Service to insure that conditionally registering dicamba for uses on genetically engineered cotton and soybean in the thirty-four states will not jeopardize any listed species or destroy or adversely modify any of their critical habitats, *see* 16 U.S.C. § 1536 (a)(2), and to grant relief as may be appropriate.

The challenged final order was announced in a regulatory decision document that was dated and entered on EPA Docket EPA-HQ-OPP-2016-0187 on November 9, 2016, after public notice and comment, and without any agency adjudication or hearing. A copy of this final regulatory decision document is attached as Exhibit A to this petition.

Under the law of the Ninth Circuit, Petitioners are required to file their FIFRA claims in the Court of Appeals. Petitioners do not waive any argument concerning jurisdiction of claims under the ESA by including them here.

CORPORATE DISCLOSURE STATEMENT

Pursuant to Federal Rule of Appellate Procedure 26.1, Petitioners National Family Farm Coalition, Center for Food Safety, Center for Biological Diversity, and Pesticide Action Network North America certify that they have no parent corporations and that no publicly held corporation owns more than ten percent of the Petitioners.

Respectfully submitted this 20th day of January, 2017.

/s/ George A. Kimbrell

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Attorneys for Petitioners

Exhibit A

to Petition for Review



Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

A handwritten signature in black ink is written over a horizontal line. The signature is cursive and appears to read "J. E. Housenger".

Jack E. Housenger, Director
Office of Pesticide Programs

Date: _____

A handwritten date "11/9/16" is written in black ink over a horizontal line.

Summary

This document announces that the U.S. Environmental Protection Agency (the EPA or the agency) has granted a conditional registration under Section 3(c)(7)(B) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba for use on genetically-engineered (GE) cotton and GE soybean that have been engineered to be resistant to dicamba in the following states: Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

These new dicamba uses were originally proposed by the Monsanto Company to be added to the currently registered herbicide product M1691 (the EPA Registration Number 524-582). This is the specific formulation that was listed in the agency's Proposed Decision released for public comment earlier this year. Since the proposed decision was published, the agency also assessed a lower volatility dicamba formulation (M1768, with the brand name Xtendimax™ with VaporGrip™ Technology, the EPA Registration Number 524-617). the EPA expects the lower volatility formulation to further reduce the potential off site movement of generic dicamba formulations and is included in today's regulatory decision.

The M1768 product contains the same active ingredient as M1691, diglycolamine (DGA) salt of dicamba, and is to be used with equivalent application rates and the same application techniques. Because the two products contain the same active ingredient used at the same rates with the same methods, all of the environmental and human health assessments completed and made public in connection with the proposed registration decision for the M1691 apply to M1768. After assessing volatility studies conducted on the M1768 formulation (discussed later in this document), the EPA has determined that the new lower volatility formulation of M1768 offers the user a product with less potential to volatilize and move off the target area. The volatility analysis is included in the docket for this final decision. Therefore, the new uses were granted for the M1768 formulation.

This final decision document discusses several agency considerations of the new uses for dicamba on GE soybean and GE cotton, including discussions of human health and environmental risks associated with the new uses as well as the benefits associated with these uses. the EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the assessment for human health included the N, N-Bis-(3-aminopropyl) methylamine (BAPMA) salt of dicamba (M1768 contains the DGA salt of dicamba) because the data on the BAPMA salt was relevant to the analysis and presented the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. But, when product specific considerations were necessary for the analysis, the EPA reviewed the effects of the DGA salt. For example, to determine appropriate spray drift buffers, the agency examined drift potential using studies conducted on the DGA salt formulation.

Under the Plant Protection Act, the United States Department of Agriculture (USDA) deregulated the GE cotton and GE soybean seeds tolerant to dicamba on January 15, 2015.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Product: M1768 Herbicide (Xtendimax™ with VaporGrip™ Technology) EPA Registration Number 524-617

Background

On April 28, 2010 and July 30, 2012, respectively, the EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on GE soybean and GE cotton. The application also requested the establishment of new tolerances for residues resulting from the new uses. The tolerances for these new uses have been established.

Dicamba is an active ingredient that is currently used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The new uses will expand the current timing of dicamba applications to post-emergence (over-the-top) applications to GE cotton and GE soybean crops. Until this registration, dicamba was only registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. It is important to note that using registered dicamba products on GE cotton or GE soybean crops that are not registered specifically for post-emergence use on GE cotton or GE soybean crops is inconsistent with the pesticide's labeling and a violation of FIFRA.

New Uses

Cotton

Dicamba products that are currently registered on conventional cotton are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.25 to 1.0 pounds acid equivalent (lb a.e.) dicamba per acre. The maximum annual application for all preplant, at planting and pre-emergence applications combined on conventional cotton is 1.0 lb a.e. dicamba per acre per season.

For the new use, for post-emergence (in-crop) application of dicamba for use on GE cotton, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total of all in-crop applications for GE cotton is 88 fluid ounces (2.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, and pre-emergence treatments to GE cotton, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, and pre-emergence applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications (preplant, at-planting, pre-emergence and post-emergence (in-crop) must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. For example, if a preplant application of 44 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for GE cotton.

The minimum retreatment interval is 7 days; the pre-harvest interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

Dicamba products that are currently registered on conventional soybeans are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.125 to 0.5 pounds acid equivalent (lb a.e.) dicamba per acre and for preharvest burndown treatments at 0.25 to 1.0 lb a.e. dicamba per acre. The maximum annual application for all preplant, at planting, pre-emergence, and preharvest burndown applications combined on conventional soybeans is 1.0 lb a.e. dicamba per acre per season.

For the new use for post-emergence (in-crop) application of this product to GE soybeans, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total for all in-crop applications for GE soybeans is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, pre-emergence, and preharvest burndown treatments to GE soybeans, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, pre-emergence, and preharvest applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay, is 14 days (R1 Growth stage).

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human

health risk assessment for dicamba, risks were assessed in a manner that protects human health from exposure to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data show greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, the EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. The EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, the EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the agency assumes that any amount of exposure will lead to some degree of risk. Thus, the agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be "not likely" to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles the EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2)

more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.

- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. Since the BAPMA salt shows increased toxicity via inhalation, the BAPMA was included in the aggregate risk assessment. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment for these new uses. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The agency determined, based on review of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, the EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, the EPA assumes that any amount of exposure will lead to some degree of risk. Thus, the EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity

study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainly factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and as discussed in Section C below, 1X for FQPA SF when applicable). The inhalation HEC results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined, and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite lacked findings of carcinogenicity in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

The EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) There is no evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (i) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (ii) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (iii) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models (e.g., models using screening level assumptions). Therefore, the agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

The EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other

substances. Therefore, the EPA finds for this decision that dicamba does not have a common mechanism of toxicity with other substances. For information regarding the EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by the EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on the EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities. Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with the EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the POD for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and new uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the agency's LOC for both food and water. For the U.S. population, the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting

residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being established for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to the agency's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

Since dicamba products registered for use on residential turf come in both liquid and granular

formulations, both are accounted for in this assessment. The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application Inhalation Exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the new uses of dicamba on GE corn and GE soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. In general, volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40-acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Although a more recent volatility study conducted using the M1768 formulation was submitted and reviewed, which demonstrated comparable potential for volatility as described in greater detail in the document entitled *Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton* available in the docket for this action, that study was not available at the time this Human Health assessment was developed. Results of PERFUM modeling using the Bradenton, FL study however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates for potential human bystander exposure are not of concern.

4. Spray Drift

Without considering mitigation measures, it is reasonable to assume that spray drift may be a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The maximum single application rate of dicamba for this new use is 1 lb a.e./A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. This spray drift fraction estimation differs from that used for environmental exposures because, unlike environmental risk assessment that uses estimations to determine exposures at the edge of the treated field, estimations for human health risk assessment are used to assess the average deposition over a wide area of lawn. For the purposes of the new uses on dicamba, this is considered a screening level assumption since the new use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate of 1 lb a.e./A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the Federal Food, Drug, and Cosmetic Act (FFDCA), the EPA must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be

aggregated. When aggregating exposures and risks from various sources, the EPA considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- or long-term durations via the oral, dermal, or inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and new use sites. Drinking water values were incorporated directly into the assessment. The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term Aggregate Risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short-term aggregate risks.

c. Long-term Aggregate Risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant percent crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

6. Occupational Risk Assessment

a. Short- and Intermediate-term Handler Risk

The EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on GE cotton and GE soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short- and Intermediate-term Post-application Risk

The EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard via the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation Post Application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on GE soybean and GE cotton is provided below. More detailed discussions can be found in the agency documents titled:

- *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708) and*
- *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701), and its addendums entitled,*
- *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean and*
- *Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean and*
- *M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide, EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton.*

These documents are in docket number EPA-HQ-OPP-2016-0187, available at regulation.gov. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would

likely persist; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for GE soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. Without considering mitigation measures on the product label, possible pathways for reaching surface water include field/site runoff, spray drift during application, and vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. Without considering mitigation measures, the major route of exposure to non-target organisms is likely spray drift and runoff. While multiple literature studies show that there is potential for high vapor drift for certain dicamba salts and formulations from soybean fields resulting in non-target plant injury, the available dicamba M1768 formulation volatility research the agency has reviewed indicates that non-target plant biomass and yield will not be affected by use of the M1768 formulation. The assessments, which can be found in the docket for this action, related to these routes of exposure are described in the sections below.

3. Runoff

The agency considered the potential effects due to runoff and developed mitigation to limit off-site runoff that is reflected in the approved labeling for these new uses (e.g., Do not make application of this product if rain is expected in the next 24 hours.). A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

Without consideration of mitigation measures on the approved label, the agency considers spray drift exposure to be the principal risk issue to be considered with these new uses, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following applications of currently registered dicamba products (not containing the same labeling restrictions), likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). The EPA determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. The approved labeling for this action contains these restrictions. Based on the weight of evidence approach, the EPA also determined that labels must include language to maintain an in-field buffer (downwind at the time of application) of 110 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (i.e., NOAEC for soybean plant height). The approved labeling for this action includes these restrictions.

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, and at the time the EPA proposed these new uses, the agency had concerns regarding the volatility of dicamba and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with an additional submission post-proposal that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Based on field volatility (flux) studies (conducted in accordance with the label conditions such as nozzle and ground speed limitations) and laboratory vapor-phase toxicity and exposure (humidome) studies, the 110-foot omnidirectional buffer for volatilization is no longer warranted for the dicamba DGA plus VaporGrip™ (M1768) formulation, because the expected exposure at field's edge is less than the NOAEC for plant risk.

The EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints (plant height and yield) are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (i.e., plant height) for the most sensitive plant species tested (i.e., soybeans), the EPA uses field studies and modeling to determine the distance from site of application to where the NOAEC is not expected to be exceeded. It is further noted that the labels for the new uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and

chronic ($RQ = \text{Exposure}/\text{Toxicity}$). RQs are then compared to the EPA's levels of concern (LOCs). The LOCs are criteria used by the agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOAEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including conventional cotton and soybean. The new uses on GE soybeans and GE cotton expand the timing of applications from only pre-emergence and pre-harvest for soybeans and only pre-emergence and post-harvest for cotton to allowing post-emergence over-the-top applications on these GE crops. The maximum yearly application rates would remain 2.0 lb a.e./A for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./A between pre-emergence and post-emergence applications.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening - level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations at the species-specific level.

The results of the screening-level risk assessments indicate that the RQs do not exceed the agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the agency's LOC. The screening-level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both GE cotton and GE soybeans, based on the new maximum application rates, the screening-

level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, the potential for ecological concerns is related to the potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in GE soybeans. Before considering mitigation measures, the EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening-level assessment, further refinement, as discussed below, suggest that risks are lower and confined to the treated field under the mitigations imposed on the registration. Risks above the level of concern remain for terrestrial plants and animals on the treated field; comparison of the risk to benefits associated with the new use are described in Section VIII.

1. Risk to Birds

For birds, the screening-level assessment (which assumed that 100% of diet is from the treated field) indicated that the RQs exceeded the agency's LOCs on an acute basis for both GE soybean and GE cotton. More specifically, the screening-level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in GE soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming GE soybean forage/hay.

The agency's screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in GE soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs. Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns. This suggests that dicamba consumed in the diet may be less available than assumed using dose-based exposures. Expected field exposure is more likely to be accounted for by the dietary studies that did not indicate risk exceeding levels of concern rather than the acute oral dose studies where risk exceeding thresholds of concern was indicated. As mentioned above, the screening-level analysis assumes that 100% of the diet comes from the treated field which may overestimate total dicamba ingestion.

Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger

concerns for many food items. In addition, estimates of exposure in screening-level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening-level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms that are off the treated field. With this last line of evidence in mind, the pesticide label requires an in-field 110 to 220-foot downwind buffer to eliminate off-site exposure above threshold levels that would trigger risk concern for birds (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for birds feeding on GE plants on the field, and are not expected off the field (since DCSA formation is only a result of dicamba tolerant-plant metabolism).

2.Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the agency’s LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening-level assessment using the maximum exposure values from empirical datasets for DCSA residues in GE soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. The screening-level assessment using the maximum exposure values from empirical data for DCSA residues in GE cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The agency’s screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in GE soybeans and GE cotton plants to determine the RQ values. The EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas. As described in the section for risk to birds, the screening-level assessment assumes that 100% of the diet comes from the treated field.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the pesticide label requires an in-field 110 to 220-foot downwind buffer eliminate off-site exposure above threshold levels that would trigger risk concern for mammals (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for mammals feeding on GE plants on the field, and are not expected off the field.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the new uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift (without mitigation measures), and for dicots in semi-aquatic areas due to runoff and spray drift (without mitigation measures). The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that the approved labeling restrictions will keep the product on the field, thereby reducing spray drift off field. These determinations were made after reviewing additional registrant submitted studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and a change in the formulation to be registered. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1768 Herbicide when an in-field 110 to 220-foot downwind buffer is incorporated between the application equipment and the edges of the treated field. Therefore, potential risks to plants from spray drift is mitigated by requiring a 110-220 foot (depending on application rate) buffer downwind at the time of application.

4. Synergism

The agency views synergism to be a rare event and intends to follow the National Research Council's recommendation for government agencies to proceed with estimating effects of pesticide mixtures with the assumption that the components have additive effects¹ in the absence of any data to support the hypothesis of a synergistic interaction between pesticide active ingredients. However, data is being cited in connection with patent claims submitted to the U.S. Patent and Trademark Office (USPTO) for claims of synergism for specific combinations of dicamba with other herbicides.

The EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings with the USPTO where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. The endpoints in these patent application studies were based on visual observations of weed control and injury, and so were not directly applicable to the EPA's quantitative risk assessment process for plants, in which measures of sub-lethal effects (plant height and weight) serve as sensitive effects thresholds for risk estimation purposes. The EPA believes this quantitative

¹ The phrase 'additive effects' is used when the effect of the combination of chemicals can be estimated directly from the sum of the scaled exposure levels (dose addition) or of the responses (response addition) of the individual components.

approach is very reliable for the purpose of potential toxicity to plants.

The agency is continuing its work with that information in order to better understand the scope of these uncertainties for these specific combinations and to develop an approach that best manages the potential risks while still maintaining the important benefits derived from tank mixing. While evaluation of these data are still in progress, the agency is requiring that the end-use product label allow only tank mixing with other herbicides in combinations that have not been granted patents for synergistic behavior at the time of this registration. For prohibited combinations, if the EPA determines that sufficient data do not exist to support synergistic effects with a particular active ingredient, or if the agency has evaluated data that is more directly applicable to the agency's quantitative risk assessment process for plants that demonstrates that no increased toxicity to plants exists and are therefore not of concern, that ingredient may then be allowed in tank mix combinations. A list of acceptable tank mixes will be maintained by Monsanto on their already established website, www.xtendimaxapplicationrequirements.com

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this final decision.

In the screening-level risk assessment performed for the new application timing of dicamba (DGA) on GE cotton and GE soybean to be resistant to dicamba, the EPA determined that levels of concern were not exceeded for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on GE seeds to be resistant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at [species/ecological-risk-assessment-process-under-endangered-species-act](http://www.epa.gov/species/ecological-risk-assessment-process-under-endangered-species-act)]. That assessment uses broad default assumptions to establish estimated

environmental concentrations of particular pesticides. If the screening-level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, the EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. The EPA determines that there is “no effect” on listed species if, at any step in the screening-level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening-level assessment, a pesticide still exceeds the agency’s levels of concern for listed species, the EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening-level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening-level risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to the EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening-level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a No Effect determination is identified for the corresponding taxon.

This registration for dicamba has been finalized for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an acceptable assessment of listed species is completed for any such state.

Based on the EPA’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), the EPA identified the listed species that are inside the “action area” (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 34 states.

The following criteria are used to make a species-specific effects determination:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY EFFECT categories depending upon their specific biological needs and circumstances of exposure.
- Those that fall under the MAY EFFECT category are found to be either LIKELY or NOT LIKELY TO ADVERSELY AFFECT the listed species.
A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial
- A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift label mitigation language including an in-field spray drift buffer of 110 feet (for the 0.5 lb/A rate) and 220 feet (for the 1.0 lb/A rate) downwind at the time of application is expected to limit off site transport of dicamba DGA through spray drift. Therefore, the EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, the EPA concluded a NO EFFECT determination for all but 24 species originally identified as potentially at-risk (in the screening-level assessment) because they are not expected to occur on cotton and soybean fields.

The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in the EPA's refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, the EPA made a determination that exposure occurring on the field would have "may affects" (either "unlikely to adversely affect" or "likely to adversely affect" on 3 species (the Eskimo Curlew, the Spring Creek Bladderpod in Wilson county, TN, and the Audubon Crested Caracara in Palm Beach county, FL) within the States covered by this final decision. The EPA initiated informal consultation with the U.S. Fish and Wildlife Service (FWS) for the Eskimo curlew. The FWS concurred with the "unlikely to adversely affect" determination and no further action need be taken relative to this species. Furthermore, to address the remaining effects, the registrant submitted revised labeling and the EPA approved the labeling that prohibits application in both Wilson county, TN and Palm Beach county, FL. Therefore, the EPA makes no effect determinations for all listed species that are expected to be on the treated fields.

Additionally, the agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, the EPA's analysis also supports a no effects determination for runoff exposure for off-field listed plants for the new labeled use of dicamba DGA. To further protect species off the treated field against runoff, rainfast mitigation is required on the label ("Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.").

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on GE crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, the EPA is requiring, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a lack of performance can obtain direct support from Monsanto through a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, the EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the new uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and

contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers' permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to the EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15, 2018, on or before January 15th of each year thereafter, Monsanto must submit annual summary reports to the EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the final dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for the EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The agency received 21,710 comments in response to the public participation process (Docket ID: the EPA-HQ-OPP-2016-0187) regarding the EPA's proposed decision for the application to register the use of dicamba on GE cotton and GE soybeans. Comments received were both in favor of and opposed to the decision to register the new uses which will provide growers with additional tools to control broadleaf weeds. The EPA welcomes input from the public during the decision process when registering significant new uses, and is committed to reviewing the comments received and determining whether changes or further mitigation are necessary to meet the applicable statutory standards. The EPA reviewed and evaluated the comments received during the comment period before issuing this final regulatory decision. Since many of the comments covered similar concerns, the comments were grouped into major topic areas. Please see *Response to Public Comments Received Regarding the New Use of Dicamba on Dicamba-Tolerant Cotton and Soybeans* dated November 7, 2016 for the agency's response to these comments.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest

management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Previously registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the previously registered uses of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba will expand weed management options on GE cotton and GE soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season will target new flushes of weeds, thereby reducing populations of these weeds and particularly will help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Registration Decision

In accordance with FIFRA, the EPA only registers a pesticide when it finds that the use will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, the EPA is charged with balancing the uncertainties and risks posed by a pesticide against the benefits associated with the use of the pesticide. The EPA must determine if the benefits in light of its use outweigh the risks in order for the agency to register a pesticide.

In the case for the new uses of dicamba on GE soybeans and GE cotton, and in consideration of all best available data and assessment methods, the EPA determines that its decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered complete and adequate to evaluate risks to infants and children. The agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some LOCs were exceeded for certain birds, reptiles, amphibians, and mammals that may be in the treated fields. These assessments included conservative risk estimates using screening-level (worst case) assumptions that are unlikely to apply to the majority of the birds, reptiles, amphibians, and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated field. Because of these additional restrictions, the EPA expects these uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the agency's levels of concern.

On the benefits side of the analysis, use of dicamba on GE soybeans and GE cotton is expected to become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed

and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of the United States soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states in the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on GE soybeans and GE cotton is beneficial as it provides an effective tool to treat especially noxious weeds, such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba can help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to GE soybean and GE cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the approved labeling restrictions will include further beneficial protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

The EPA finds these benefits important. Furthermore, this regulatory decision includes a number of requirements that are expected to effectively limit concerns for off field risk. This registration action is only for a product confirmed by data to be a lower volatility formulation. In addition, the label requires very specific and rigorous drift mitigation measures, including in-field buffers, aerial application prohibitions, boom height requirements, specific nozzle and spray pressure requirements, and wind and tractor speed limitations. These mitigations are known to profoundly impact any drift potential from pesticide application. In aggregate, these formulations and labeling requirements are expected to eliminate any offsite exposures and effectively prevent risk potential to people and non-target species.

After weighing all the risks of concern against the benefits of the new uses, the EPA finds that when the mitigation measures for these uses are applied, the benefits of the use of the pesticide outweighs any remaining minimal risks, if they exist at all. Therefore, registering these new uses will not generally cause unreasonable adverse effects on human health or the environment. the EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(7)(B) registration finding for the new uses. Although the EPA proposed registering dicamba under FIFRA section 3(c)(5), new data requirements have been identified through registration review that will be applicable to all dicamba products (and all uses), therefore the agency is registering these new uses under FIFRA section 3(c)(7)(B).

A. Data Requirements

Although there are currently no outstanding data require to support the final registration of this action, the EPA has identified data that will be required in connection with Registration Review activities for dicamba. Those requirements will be applicable to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the final supplemental labels unless otherwise noted below.

1. Worker Protection

(Although the following Worker Protection labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on May 1, 2014 for this product.)

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. Environmental Hazards

(Although the following Environmental Hazards labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on September 18, 2013 for this product.)

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1768 Herbicide for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call 1-844-RRXTEND.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season,
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use only Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying XtendiMax™ With VaporGrip™ Technology or any other approved nozzle found at www.xtendimaxapplicationrequirements.com. Do not use any other nozzle and pressure combination not specifically listed on this website. www.xtendimaxapplicationrequirements.com

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity or temperatures above 91 degrees Fahrenheit, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and can be impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Do not apply this product during a temperature inversion. Off-target movement potential can be high during a temperature inversion. During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on evenings and nights with limited cloud cover and light to no wind. Cooling of air at the earth's surface takes place and warmer air is trapped above it. They can begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing. The inversion will often dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

Buffer

Maintain a 110 foot downwind buffer (when applying 22 fluid ounces of this product per acre) or a 220 foot downwind buffer (when applying 44 fluid ounces of this product per acre) between the last treated row and the closest downwind edge (in the direction in which the wind is blowing). If any of the following areas below are directly adjacent to the treated field, the areas listed below can be considered part of the buffer distance.

To maintain this required buffer zone:

- No application swath can be initiated in, or into an area that is within the applicable buffer distance.

The following areas may be included in the buffer distance calculation when adjacent to field edges:

- Roads, paved or gravel surfaces.
- Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, sorghum, proso millet, small grains and sugarcane. If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant and not conventional cotton and/or soybeans.
- Agricultural fields that have been prepared for planting.
- Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1768 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1768 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.
- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans per year.
- The combined total application rate from crop emergence up to 7 days' pre-harvest must not exceed 88 fluid ounce (2.0lb a.e dicamba) per acre for cotton per year.
- All applications for both cotton and soybeans must not exceed 88 fluid ounces (2.0 lb a.e dicamba) per acre per year.

C. Registration Terms

The EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. The EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. The EPA is basing the final registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., "Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations," *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

The EPA is issuing this registration with a term that requires Monsanto to have an Herbicide Resistance Management (HRM) Plan for M1768 Herbicide. The HRM Plan will focus on educating growers on the appropriate use of the M1768 Herbicide and the associated dicamba-tolerant seeds. The EPA is requiring that the HRM plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

The EPA is requiring that Monsanto or its representative investigate reports of lack of herbicide efficacy as reported by users following "scouting." When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for

“likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures. Additionally, Monsanto must routinely collect plant material for further testing.

c. Annual Reporting of Herbicide Resistance to the EPA

Monsanto must submit annual summary reports to the EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

D. Registration Expiration

The issue of weed resistance is an extremely important issue to keep under control and can be very fast moving. Also, the EPA is aware of reports of off-site incidents potentially due to the illegal use of dicamba products that do not employ the lower volatility formulation of dicamba DGA plus VaporGrip™ (M-1768) on GE cotton and GE soybean. Although the EPA finds that herbicide resistance is adequately addressed by the required herbicide resistance plan and does not expect off-site incidents to occur due to the specific measures required (described above) to this registration, the agency is requiring expiration dates that will ensure that the EPA retains the ability to easily modify the registration or allow the registration to terminate if necessary.

Specifically, this registration automatically expires on November 9, 2018, unless the EPA determines before that date that off-site incidents are not occurring at unacceptable frequencies or levels. If this automatic expiration date is amended (in whatever way the EPA determines is appropriate at the time), it shall not be amended to a date later than November 9, 2021, by which date this registration will automatically expire unless the EPA determines before that date that

herbicide resistance to dicamba is not occurring at unacceptable frequencies or levels, and that off-site incidents are not occurring at unacceptable frequencies or levels.

E. Geographic Limitation on Use of Dicamba M1768 Herbicide

The EPA is issuing these new uses only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62. <http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>

CERTIFICATE OF SERVICE

I am over eighteen years of age and not a party to this action. I am employed in the county where the mailing took place. My business address is 303 Sacramento Street, 2nd Floor, San Francisco, CA 94111.

I hereby certify that on January 20, 2017, I caused to be served one true and correct copy of the **PETITION FOR REVIEW and CORPORATE**

DISCLOSURE STATEMENT via certified mail on the following persons:

Loretta Lynch
U.S. Attorney General
950 Pennsylvania Avenue, NW
Washington, DC 20530-0001
Telephone: (202) 514-2001

Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Office of the Administrator, 1101A
Washington, DC 20460
Telephone: (202) 564-4700
Facsimile: (202) 501-1450

Correspondence Control Unit
Office of General Counsel (2311)
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW,
Washington, DC 20460

Brian Stretch
c/o Civil Process Clerk
United States Attorney for the
Northern District of California
450 Golden Gate Avenue
San Francisco, CA 94102

John C. Cruden
Assistant Attorney General
U.S. Department of Justice
Environment & Natural Resources
Division
Law and Policy Section
P.O. Box 4390
Ben Franklin Station
Washington, DC 20044-4390
Telephone: (202) 514-2701
Facsimile: (202) 514-0557

/s/ Effie Shum

Legal Assistant

Message

From: Grosko, Brett (ENRD) [Brett.Grosko@usdoj.gov]
Sent: 1/24/2017 9:13:18 PM
To: Wakefield, Benjamin J. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b2756b86404b49448581918fd2fbc13c-BWAKEFIE]; Allen, Michelle [michelle.allen@dot.gov]
Subject: Dicamba
Attachments: ENV_DEFENSE-#793832-v1-admin_su_fifra_dicamba_petition.PDF



Office of the Clerk
United States Court of Appeals for the Ninth Circuit
Post Office Box 193939
San Francisco, California 94119-3939
415-355-8000

Molly C. Dwyer
Clerk of Court

January 20, 2017

No.: 17-70196
Short Title: National Family Farm Coalition, et al v. USEPA, et al

Dear Petitioners/Counsel

Your Petition for Review has been received in the Clerk's office of the United States Court of Appeals for the Ninth Circuit. The U.S. Court of Appeals docket number shown above has been assigned to this case. You must indicate this Court of Appeals docket number whenever you communicate with this court regarding this case.

The due dates for filing the parties' briefs and otherwise perfecting the petition have been set by the enclosed "Time Schedule Order," pursuant to applicable FRAP rules. These dates can be extended only by court order. Failure of the petitioner to comply with the time schedule order will result in automatic dismissal of the petition. 9th Cir. R. 42-1.

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

FILED

JAN 20 2017

MOLLY C. DWYER, CLERK
U.S. COURT OF APPEALS

NATIONAL FAMILY FARM
COALITION; CENTER FOR FOOD
SAFETY; CENTER FOR
BIOLOGICAL DIVERSITY;
PESTICIDE ACTION NETWORK
NORTH AMERICA,

Petitioners,

v.

U.S. ENVIRONMENTAL
PROTECTION AGENCY; GINA
MCCARTHY, in her official capacity as
Administrator,

Respondents.

No. 17-70196

EPA No.
Environmental Protection Agency

TIME SCHEDULE ORDER

The parties shall meet the following time schedule.

- | | |
|-------------------------------|---|
| Mon., January 30, 2017 | Mediation Questionnaire due. If your registration for Appellate ECF is confirmed after this date, the Mediation Questionnaire is due within one day of receiving the email from PACER confirming your registration. |
| Mon., April 10, 2017 | Petitioners' opening brief and excerpts of record shall be served and filed pursuant to FRAP 32 and 9th Cir. R. 32-1. |

Wed., May 10, 2017

Respondents' answering brief and excerpts of record shall be served and filed pursuant to FRAP 32 and 9th Cir. R. 32-1.

The optional petitioners' reply brief shall be filed and served within fourteen days of service of the respondents' brief, pursuant to FRAP 32 and 9th Cir. R. 32-1.

Failure of the petitioners to comply with the Time Schedule Order will result in automatic dismissal of the appeal. See 9th Cir. R. 42-1.

FOR THE COURT:

MOLLY C. DWYER
CLERK OF COURT

By: Wendy Lam
Deputy Clerk
Ninth Circuit Rule 27-7



United States Court of Appeals
for the Ninth Circuit

P.O. Box 31478
Billings, Montana 59107-1478

CHAMBERS OF
SIDNEY R. THOMAS
CHIEF JUDGE

December 1, 2014

TEL: (406) 373-3200
FAX: (406) 373-3250

Dear Counsel:

I want to take this opportunity to introduce you to the Court's mediation program. The court offers you and your clients professional mediation services, at no cost, to help resolve disputes quickly and efficiently and to explore the development of more satisfactory results than can be achieved from continued litigation. Each year the mediators facilitate the resolution of hundreds of cases, from the most basic contract and tort actions to the most complex cases involving multiple parties, numerous pieces of litigation and important issues of public policy.

The eight circuit mediators, all of whom work exclusively for the court, are highly experienced attorneys from a variety of practices; all have extensive training and experience in negotiation, appellate mediation, and Ninth Circuit practice and procedure. Although the mediators are court employees, the Court has adopted strict confidentiality rules and practices to ensure that what goes on in mediation stays in mediation. *See* Circuit Rule 33-1.

The first step in the mediation process is case selection. To assist the mediators in the case selection process, appellants/petitioners must file a completed Mediation Questionnaire within 7 days of the docketing of the case. *See* Circuit Rules 3-4, and 15-2. Appellees may also fill out and file a questionnaire. The questionnaire with filing instructions accompanies this letter and is also available at www.ca9.uscourts.gov/mediation/forms.php. All counsel are also invited to submit, by e-mail to ca09_mediation@ca9.uscourts.gov, additional, confidential information that might assist the mediators in the case selection process.

Page 2

In most cases, the mediator will schedule a settlement assessment conference, with counsel only, to determine whether the case is suitable for mediation. Please be assured that participation in the mediation program will not slow down disposition of your appeal. Mediation discussions are not limited to the issues on appeal. The discussions can involve other cases and may include individuals who are not parties to the litigation, if doing so enables the parties to reach a global settlement.

Further information about the mediation program may be found on the court's website: www.ca9.uscourts.gov/mediation/. Please address questions directly to the Mediation Unit at 415-355-7900 or ca09mediation@ca9.uscourts.gov.

Our mediators do a terrific job. I hope you'll give them the opportunity to work on your case.

Sincerely,

A handwritten signature in cursive script, appearing to read "Sidney R. Thomas".

Sidney R. Thomas
Chief Circuit Judge

UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

Circuit Mediation Office

Phone (415) 355-7900 Fax (415) 355-8566

<http://www.ca9.uscourts.gov/mediation>**MEDIATION QUESTIONNAIRE**

This form is available in a fillable version at http://cdn.ca9.uscourts.gov/datastore/uploads/forms/Mediation_Questionnaire.pdf.

The purpose of this questionnaire is to help the court's mediators provide the best possible mediation service in this case; it serves no other function. Responses to this questionnaire are **not** confidential. Appellants/Petitioners must electronically file this document within 7 days of the docketing of the case. 9th Cir. R. 3-4 and 15-2. Appellees/Respondents may file the questionnaire, but are not required to do so.

9th Circuit Case Number(s):	<input style="width: 100%;" type="text"/>		
District Court/Agency Case Number(s):	<input style="width: 100%;" type="text"/>		
District Court/Agency Location:	<input style="width: 100%;" type="text"/>		
Case Name:	<input style="width: 30%;" type="text"/>	v.	<input style="width: 30%;" type="text"/>
If District Court, docket entry number(s) of order(s) appealed from:	<input style="width: 100%;" type="text"/>		
Name of party/parties submitting this form:	<input style="width: 100%;" type="text"/>		

Briefly describe the dispute that gave rise to this lawsuit.

Briefly describe the result below and the main issues on appeal.

(Continue to next page)

Describe any proceedings remaining below or any related proceedings in other tribunals.

Provide any other thoughts you would like to bring to the attention of the mediator.

*Any party may provide additional information **in confidence** directly to the Circuit Mediation Office at ca09_mediation@ca9.uscourts.gov. Provide the case name and Ninth Circuit case number in your message. Additional information might include level of interest in including this case in the mediation program, the case's settlement history, issues beyond the litigation that the parties might address in a settlement context, or future events that might affect the parties' willingness or ability to mediate the case.*

CERTIFICATION OF COUNSEL

I certify that:

☐ a current service list with telephone and fax numbers and email addresses is attached (see 9th Circuit Rule 3-2).

☐ I understand that failure to provide the Court with a completed form and service list may result in sanctions, including dismissal of the appeal.

Signature

("s/" plus attorney name may be used in lieu of a manual signature on electronically-filed documents.)

Counsel for

How to File: Complete the form and then convert the filled-in form to a static PDF (File > Print > PDF Printer or any PDF Creator). To file, log into Appellate ECF and select File Mediation Questionnaire. (*Use of the Appellate ECF system is mandatory for all attorneys filing in this Court, unless they are granted an exemption from using the system.*)

UNITED STATES COURT OF APPEALS for the NINTH CIRCUIT**Office of the Clerk****After Opening a Case – Counseled Non-Immigration Agency Cases**
(revised April 2016)**Court Address – San Francisco Headquarters**

<i>Mailing Address for U.S. Postal Service</i>	<i>Mailing Address for Overnight Delivery (FedEx, UPS, etc.)</i>	<i>Street Address</i>
Office of the Clerk James R. Browning Courthouse U.S. Court of Appeals P.O. Box 193939 San Francisco, CA 94119-3939	Office of the Clerk James R. Browning Courthouse U.S. Court of Appeals 95 Seventh Street San Francisco, CA 94103-1526	95 Seventh Street San Francisco, CA 94103

Court Addresses – Divisional Courthouses

<i>Pasadena</i>	<i>Portland</i>	<i>Seattle</i>
Richard H. Chambers Courthouse 125 South Grand Avenue Pasadena, CA 91105	The Pioneer Courthouse 700 SW 6th Ave, Ste 110 Portland, OR 97204	William K. Nakamura Courthouse 1010 Fifth Avenue Seattle, WA 98104

Court Website – www.ca9.uscourts.gov

The Court's website contains the Court's Rules and General Orders, information about electronic filing of documents, answers to frequently asked questions, directions to the courthouses, forms necessary to gain admission to the bar of the Court, opinions and memoranda, live streaming of oral arguments, links to practice manuals, and an invitation to join our Pro Bono Program.

Court Phone List

Main Phone Number	(415) 355-8000
Attorney Admissions	(415) 355-7800
Calendar Unit	(415) 355-8190
Docketing	(415) 355-7840
Death Penalty	(415) 355-8197
Electronic Filing – CM/ECF	Submit form at http://www.ca9.uscourts.gov/cmecf/feedback
Library	(415) 355-8650
Mediation Unit	(415) 355-7900
Motions Attorney Unit	(415) 355-8020
Procedural Motions Unit	(415) 355-7860
Records Unit	(415) 355-7820
Divisional Court Offices:	
Pasadena	(626) 229-7250
Portland	(503) 833-5300
Seattle	(206) 224-2200

Electronic Filing - CM/ECF

The Ninth Circuit’s CM/ECF (Case Management/Electronic Case Files) system is mandatory for all attorneys filing in this Court, unless they are granted an exemption. All non-exempted attorneys who appear in an ongoing case are required to register for and to use CM/ECF. Registration and information about CM/ECF is available on the Court’s website at www.ca9.uscourts.gov under *Electronic Filing–CM/ECF*. Read the Circuit Rules, especially Ninth Circuit Rule 25-5, for guidance on filing documents electronically via CM/ECF, and see the CM/ECF User Guide for a complete list of the available types of filing events.

Rules of Practice

The Federal Rules of Appellate Procedure (Fed. R. App. P.), the Ninth Circuit Rules (9th Cir. R.) and the General Orders govern practice before this Court. The rules are available on the Court's website at www.ca9.uscourts.gov under *Rules*.

Practice Resources

The Appellate Lawyer Representatives' Guide to Practice in the United States Court of Appeals for the Ninth Circuit is available on the Court's website www.ca9.uscourts.gov at *Guides and Legal Outlines > Appellate Practice Guide*. The Court provides other resources in *Guides and Legal Outlines*.

Admission to the Bar of the Ninth Circuit

All attorneys practicing before the Court must be admitted to the Bar of the Ninth Circuit. Fed. R. App. P. 46(a); 9th Cir. R. 46-1.1 & 46-1.2.

For instructions on how to apply for bar admission, go to www.ca9.uscourts.gov and click on the *Attorneys* tab > *Attorney Admissions > Instructions*.

Notice of Change of Address

Counsel who are registered for CM/ECF must update their personal information, including street addresses and email addresses, online at: <https://pacer.psc.uscourts.gov/pscuf/login.jsf> 9th Cir. R. 46-3.

Counsel who have been granted an exemption from using CM/ECF must file a written change of address with the Court. 9th Cir. R. 46-3.

Payment of Fees

The \$500.00 filing fee or a motion to proceed in forma pauperis shall accompany the petition. 9th Cir. R. 3-1.

A motion to proceed in forma pauperis must be supported by the affidavit of indigency found at Form 4 of the Federal Rules of Appellate Procedure, available at the Court's website, www.ca9.uscourts.gov, under *Forms*.

Failure to satisfy the fee requirement or to apply to proceed without payment of fees will result in the petition's dismissal. 9th Cir. R. 42-1.

Motions Practice

Following are some of the basic points of motion practice, governed by Fed. R. App. P. 27 and 9th Cir. R. 27-1 through 27-14.

- Neither a notice of motion nor a proposed order is required. Fed. R. App. P. 27(a)(2)(C)(ii), (iii).
- Motions may be supported by an affidavit or declaration. 28 U.S.C. § 1746.
- Each motion should provide the position of the opposing party. Circuit Advisory Committee Note to Rule 27-1(5); 9th Cir. R. 31-2.2(b)(6).
- A response to a motion is due 10 days from the service of the motion. Fed. R. App. P. 27(a)(3)(A); Fed. R. App. P. 26(c). The reply is due 7 days from service of the response. Fed. R. App. P. 27(a)(4); Fed. R. App. P. 26(c).
- A response requesting affirmative relief must include that request in the caption. Fed. R. App. P. 27(a)(3)(B).
- A motion filed after a case has been scheduled for oral argument, has been argued, is under submission or has been decided by a panel, must include on the initial page and/or cover the date of argument, submission or decision and, if known, the names of the judges on the panel. 9th Cir. R. 25-4.

Emergency or Urgent Motions

All emergency and urgent motions must conform with the provisions of 9th Cir. R. 27-3. Note that a motion requesting procedural relief (e.g., an extension of time to file a brief) is *not* the type of matter contemplated by 9th Cir. R. 27-3. Circuit Advisory Committee Note to 27-3(3).

Prior to filing an emergency motion, the moving party *must* contact an attorney in the Motions Unit in San Francisco at (415) 355-8020.

When it is absolutely necessary to notify the Court of an emergency outside of standard office hours, the moving party shall call (415) 355-8000. Keep in mind that this line is for true emergencies that cannot wait until the next business day (e.g., an imminent execution or removal from the United States).

Briefing Schedule

The Court sets the briefing schedule at the time the petition is docketed.

Certain motions (e.g., a motion for dismissal) automatically stay the briefing schedule. 9th Cir. R. 27-11.

The opening and answering brief due dates are not subject to the additional time described in Fed. R. App. P. 26(c). 9th Cir. R. 31-2.1. The early filing of petitioner's opening brief does not advance the due date for respondent's answering brief. *Id.*

Extensions of Time to file a Brief

Streamlined Request

Subject to the conditions described at 9th Cir. R. 31-2.2(a), you may request one streamlined extension of up to 30 days from the brief's existing due date. Submit your request via CM/ECF using the "File Streamlined Request to Extend Time to File Brief" event on or before your brief's existing due date. No form or written motion is required.

Written Extension

Requests for subsequent extensions or extensions of more than 30 days will be granted only upon a written motion supported by a showing of diligence and substantial need. This motion shall be filed at least 7 days before the due date for the brief. The motion shall be accompanied by an affidavit or declaration that includes all of the information listed at 9th Cir. R. 31-2.2(b).

The Court will ordinarily adjust the schedule in response to an initial motion. Circuit Advisory Committee Note to Rule 31-2.2. The Court expects that the brief will be filed within the requested period of time. *Id.*

Contents of Briefs and Record

The required components of a brief are set out at Fed. R. App. P. 28 and 32, and 9th Cir. R. 28-2, 32-1 and 32-2.

The content and filing of the record are governed by Fed. R. App. P. 16(a) and 17. If respondent does not file the record or certified list by the specified date, petitioner may move to amend the briefing schedule.

After the electronically submitted brief has been reviewed, the Clerk will request 7 paper copies of the brief that are identical to the electronic version. 9th Cir. R. 31-1. Do not submit paper copies until directed to do so.

Excerpts of Record

The Court requires Excerpts of Record rather than an Appendix. 9th Cir. R. 30-1.1. Please review 9th Cir. R. 17-1.3 through 17-1.6 to see a list of the specific contents and format. For Excerpts that exceed 75 pages, the first volume must comply with 9th Cir. R. 17-1.6 and 30-1.6(a). Excerpts exceeding 300 pages must be filed in multiple volumes. 9th Cir. R. 30-1.6(a).

Respondent may file supplemental Excerpts, and petitioner may file further Excerpts. 9th Cir. R. 17-1.7; 17-1.8; 30-1.7 and 30-1.8. If you are a respondent responding to a pro se brief that did not come with Excerpts, then your Excerpts need only include the contents set out at 9th Cir. R. 30-1.7.

Excerpts must be submitted in PDF format in CM/ECF on the same day the filer submits the brief. The filer shall serve a paper copy of the Excerpts on any party not registered for CM/ECF.

If the Excerpts contain sealed materials, you must submit the sealed documents electronically in a separate volume in a separate transaction from the unsealed volumes, along with a motion to file under seal. 9th Cir. R. 27-13(e). Sealed filings must be served on all parties by mail, or if mutually agreed by email, rather than through CM/ECF noticing.

After electronic submission, the Court will direct the filer to file 4 separately-bound paper copies of the excerpts of record with white covers.

Mediation Program

Mediation Questionnaires are required in all counseled agency cases except those cases seeking review of a Board of Immigration Appeals decision. 9th Cir. R.

15-2.

The Mediation Questionnaire is available on the Court's website at www.ca9.uscourts.gov under *Forms*. The Mediation Questionnaire should be filed within 7 days of the docketing of the petition. The Mediation Questionnaire is used only to assess settlement potential.

If you are interested in requesting a conference with a mediator, you may call the Mediation Unit at (415) 355-7900, email ca09_mediation@ca9.uscourts.gov or make a written request to the Chief Circuit Mediator. You may request conferences confidentially. More information about the Court's mediation program is available at <http://www.ca9.uscourts.gov/mediation>.

Oral Hearings

Approximately 14 weeks before a case is set for oral hearing, the parties are notified of the hearing dates and locations and are afforded 3 days from the date of those notices to inform the Court of any conflicts. Notices of the actual calendars are then distributed approximately 10 weeks before the hearing date.

The Court will change the date or location of an oral hearing only for good cause, and requests to continue a hearing filed within 14 days of the hearing will be granted only upon a showing of exceptional circumstances. 9th Cir. R. 34-2.

Oral hearing will be conducted in all cases unless all members of the panel agree that the decisional process would not be significantly aided by oral argument. Fed. R. App. P. 34(a)(2).

Oral arguments are live streamed to YouTube and can be accessed on the Court's website.

Ninth Circuit Appellate Lawyer Representatives APPELLATE MENTORING PROGRAM

1. Purpose

The Appellate Mentoring Program is intended to provide mentoring on a voluntary basis to attorneys who are new to federal appellate practice or would benefit from guidance at the appellate level. In addition to general assistance regarding federal appellate practice, the project will provide special focus on two substantive areas of practice - immigration law and habeas corpus petitions. Mentors will be volunteers who have experience in immigration, habeas corpus, and/or appellate practice in general. The project is limited to counseled cases.

2. Coordination, recruitment of volunteer attorneys, disseminating information about the program, and requests for mentoring

Current or former Appellate Lawyer Representatives (ALRs) will serve as coordinators for the Appellate Mentoring Program. The coordinators will recruit volunteer attorneys with appellate expertise, particularly in the project's areas of focus, and will maintain a list of those volunteers. The coordinators will ask the volunteer attorneys to describe their particular strengths in terms of mentoring experience, substantive expertise, and appellate experience, and will maintain a record of this information as well.

The Court will include information about the Appellate Mentoring Program in the case opening materials sent to counsel and will post information about it on the Court's website. Where appropriate in specific cases, the Court may also suggest that counsel seek mentoring on a voluntary basis.

Counsel who desire mentoring should contact the court at mentoring@ca9.uscourts.gov, and staff will notify the program coordinators. The coordinators will match the counsel seeking mentoring with a mentor, taking into account the mentor's particular strengths.

3. The mentoring process

The extent of the mentor's guidance may vary depending on the nature of the case, the mentee's needs, and the mentor's availability. In general, the mentee should initiate contact with the mentor, and the mentee and mentor should determine together how best to proceed. For example, the areas of guidance may range from

basic questions about the mechanics of perfecting an appeal to more sophisticated matters such as effective research, how to access available resources, identification of issues, strategy, appellate motion practice, and feedback on writing.

4. Responsibility/liability statement

The mentee is solely responsible for handling the appeal and any other aspects of the client's case, including all decisions on whether to present an issue, how to present it in briefing and at oral argument, and how to counsel the client. By participating in the program, the mentee agrees that the mentor shall not be liable for any suggestions made. In all events, the mentee is deemed to waive and is estopped from asserting any claim for legal malpractice against the mentor.

The mentor's role is to provide guidance and feedback to the mentee. The mentor will not enter an appearance in the case and is not responsible for handling the case, including determining which issues to raise and how to present them and ensuring that the client is notified of proceedings in the case and receives appropriate counsel. The mentor accepts no professional liability for any advice given.

5. Confidentiality statement

The mentee alone will have contact with the client, and the mentee must maintain client confidences, as appropriate, with respect to non-public information.

UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

NATIONAL FAMILY FARM
COALITION, CENTER FOR FOOD
SAFETY, CENTER FOR
BIOLOGICAL DIVERSITY, and
PESTICIDE ACTION NETWORK
NORTH AMERICA,

Petitioners,

v.

UNITED STATES
ENVIRONMENTAL PROTECTION
AGENCY, and GINA MCCARTHY,
in her official capacity as
Administrator,

Respondents.

Case No.

PETITION FOR REVIEW

and

**CORPORATE DISCLOSURE
STATEMENT**

PETITION FOR REVIEW

Pursuant to Section 16(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. § 136n(b), and Rule 15(a) of the Federal Rules of Appellate Procedure, Petitioners National Family Farm Coalition, Center for Food Safety, Center for Biological Diversity, and Pesticide Action Network North America (collectively Petitioners) hereby petition this Court to review the final order of the United States Environmental Protection Agency (EPA) granting a

conditional registration for the new uses of the herbicide dicamba for use on genetically engineered cotton and soybean that have been engineered to resist dicamba in thirty-four states. Petitioners respectfully petition this Court to find that (1) EPA violated its duties under FIFRA in issuing the conditional registration, and (2) EPA violated the Agency's duties under the Endangered Species Act (ESA), 16 U.S.C. §§ 1533-44, by failing to consult with the United States Fish and Wildlife Service or the National Marine Fisheries Service to insure that conditionally registering dicamba for uses on genetically engineered cotton and soybean in the thirty-four states will not jeopardize any listed species or destroy or adversely modify any of their critical habitats, *see* 16 U.S.C. § 1536 (a)(2), and to grant relief as may be appropriate.

The challenged final order was announced in a regulatory decision document that was dated and entered on EPA Docket EPA-HQ-OPP-2016-0187 on November 9, 2016, after public notice and comment, and without any agency adjudication or hearing. A copy of this final regulatory decision document is attached as Exhibit A to this petition.

Under the law of the Ninth Circuit, Petitioners are required to file their FIFRA claims in the Court of Appeals. Petitioners do not waive any argument concerning jurisdiction of claims under the ESA by including them here.

CORPORATE DISCLOSURE STATEMENT

Pursuant to Federal Rule of Appellate Procedure 26.1, Petitioners National Family Farm Coalition, Center for Food Safety, Center for Biological Diversity, and Pesticide Action Network North America certify that they have no parent corporations and that no publicly held corporation owns more than ten percent of the Petitioners.

Respectfully submitted this 20th day of January, 2017.

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Exhibit A

to Petition for Review



Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

A handwritten signature in black ink is written over a horizontal line. The signature is cursive and appears to read "J. E. Housenger".

Jack E. Housenger, Director
Office of Pesticide Programs

Date: _____

A handwritten date "11/9/16" is written in black ink over a horizontal line.

Summary

This document announces that the U.S. Environmental Protection Agency (the EPA or the agency) has granted a conditional registration under Section 3(c)(7)(B) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba for use on genetically-engineered (GE) cotton and GE soybean that have been engineered to be resistant to dicamba in the following states: Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

These new dicamba uses were originally proposed by the Monsanto Company to be added to the currently registered herbicide product M1691 (the EPA Registration Number 524-582). This is the specific formulation that was listed in the agency's Proposed Decision released for public comment earlier this year. Since the proposed decision was published, the agency also assessed a lower volatility dicamba formulation (M1768, with the brand name Xtendimax™ with VaporGrip™ Technology, the EPA Registration Number 524-617). the EPA expects the lower volatility formulation to further reduce the potential off site movement of generic dicamba formulations and is included in today's regulatory decision.

The M1768 product contains the same active ingredient as M1691, diglycolamine (DGA) salt of dicamba, and is to be used with equivalent application rates and the same application techniques. Because the two products contain the same active ingredient used at the same rates with the same methods, all of the environmental and human health assessments completed and made public in connection with the proposed registration decision for the M1691 apply to M1768. After assessing volatility studies conducted on the M1768 formulation (discussed later in this document), the EPA has determined that the new lower volatility formulation of M1768 offers the user a product with less potential to volatilize and move off the target area. The volatility analysis is included in the docket for this final decision. Therefore, the new uses were granted for the M1768 formulation.

This final decision document discusses several agency considerations of the new uses for dicamba on GE soybean and GE cotton, including discussions of human health and environmental risks associated with the new uses as well as the benefits associated with these uses. the EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the assessment for human health included the N, N-Bis-(3-aminopropyl) methylamine (BAPMA) salt of dicamba (M1768 contains the DGA salt of dicamba) because the data on the BAPMA salt was relevant to the analysis and presented the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. But, when product specific considerations were necessary for the analysis, the EPA reviewed the effects of the DGA salt. For example, to determine appropriate spray drift buffers, the agency examined drift potential using studies conducted on the DGA salt formulation.

Under the Plant Protection Act, the United States Department of Agriculture (USDA) deregulated the GE cotton and GE soybean seeds tolerant to dicamba on January 15, 2015.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Product: M1768 Herbicide (Xtendimax™ with VaporGrip™ Technology) EPA Registration Number 524-617

Background

On April 28, 2010 and July 30, 2012, respectively, the EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on GE soybean and GE cotton. The application also requested the establishment of new tolerances for residues resulting from the new uses. The tolerances for these new uses have been established.

Dicamba is an active ingredient that is currently used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The new uses will expand the current timing of dicamba applications to post-emergence (over-the-top) applications to GE cotton and GE soybean crops. Until this registration, dicamba was only registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. It is important to note that using registered dicamba products on GE cotton or GE soybean crops that are not registered specifically for post-emergence use on GE cotton or GE soybean crops is inconsistent with the pesticide's labeling and a violation of FIFRA.

New Uses

Cotton

Dicamba products that are currently registered on conventional cotton are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.25 to 1.0 pounds acid equivalent (lb a.e.) dicamba per acre. The maximum annual application for all preplant, at planting and pre-emergence applications combined on conventional cotton is 1.0 lb a.e. dicamba per acre per season.

For the new use, for post-emergence (in-crop) application of dicamba for use on GE cotton, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total of all in-crop applications for GE cotton is 88 fluid ounces (2.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, and pre-emergence treatments to GE cotton, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, and pre-emergence applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications (preplant, at-planting, pre-emergence and post-emergence (in-crop) must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. For example, if a preplant application of 44 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for GE cotton.

The minimum retreatment interval is 7 days; the pre-harvest interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

Dicamba products that are currently registered on conventional soybeans are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.125 to 0.5 pounds acid equivalent (lb a.e.) dicamba per acre and for preharvest burndown treatments at 0.25 to 1.0 lb a.e. dicamba per acre. The maximum annual application for all preplant, at planting, pre-emergence, and preharvest burndown applications combined on conventional soybeans is 1.0 lb a.e. dicamba per acre per season.

For the new use for post-emergence (in-crop) application of this product to GE soybeans, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total for all in-crop applications for GE soybeans is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, pre-emergence, and preharvest burndown treatments to GE soybeans, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, pre-emergence, and preharvest applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay, is 14 days (R1 Growth stage).

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human

health risk assessment for dicamba, risks were assessed in a manner that protects human health from exposure to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data show greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, the EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. The EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, the EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the agency assumes that any amount of exposure will lead to some degree of risk. Thus, the agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be "not likely" to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles the EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2)

more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.

- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. Since the BAPMA salt shows increased toxicity via inhalation, the BAPMA was included in the aggregate risk assessment. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment for these new uses. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The agency determined, based on review of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, the EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, the EPA assumes that any amount of exposure will lead to some degree of risk. Thus, the EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity

study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainly factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and as discussed in Section C below, 1X for FQPA SF when applicable). The inhalation HEC results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined, and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite lacked findings of carcinogenicity in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

The EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) There is no evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (i) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (ii) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (iii) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2- generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models (e.g., models using screening level assumptions). Therefore, the agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

The EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other

substances. Therefore, the EPA finds for this decision that dicamba does not have a common mechanism of toxicity with other substances. For information regarding the EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by the EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on the EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities. Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with the EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the POD for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and new uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the agency's LOC for both food and water. For the U.S. population, the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting

residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being established for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to the agency's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

Since dicamba products registered for use on residential turf come in both liquid and granular

formulations, both are accounted for in this assessment. The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application Inhalation Exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the new uses of dicamba on GE corn and GE soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. In general, volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40-acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Although a more recent volatility study conducted using the M1768 formulation was submitted and reviewed, which demonstrated comparable potential for volatility as described in greater detail in the document entitled *Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton* available in the docket for this action, that study was not available at the time this Human Health assessment was developed. Results of PERFUM modeling using the Bradenton, FL study however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates for potential human bystander exposure are not of concern.

4. Spray Drift

Without considering mitigation measures, it is reasonable to assume that spray drift may be a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The maximum single application rate of dicamba for this new use is 1 lb a.e./A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. This spray drift fraction estimation differs from that used for environmental exposures because, unlike environmental risk assessment that uses estimations to determine exposures at the edge of the treated field, estimations for human health risk assessment are used to assess the average deposition over a wide area of lawn. For the purposes of the new uses on dicamba, this is considered a screening level assumption since the new use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate of 1 lb a.e./A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the Federal Food, Drug, and Cosmetic Act (FFDCA), the EPA must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be

aggregated. When aggregating exposures and risks from various sources, the EPA considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- or long-term durations via the oral, dermal, or inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and new use sites. Drinking water values were incorporated directly into the assessment. The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term Aggregate Risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short-term aggregate risks.

c. Long-term Aggregate Risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant percent crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

6. Occupational Risk Assessment

a. Short- and Intermediate-term Handler Risk

The EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on GE cotton and GE soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short- and Intermediate-term Post-application Risk

The EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard via the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation Post Application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on GE soybean and GE cotton is provided below. More detailed discussions can be found in the agency documents titled:

- *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708) and*
- *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701), and its addendums entitled,*
- *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean and*
- *Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean and*
- *M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide, EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton.*

These documents are in docket number EPA-HQ-OPP-2016-0187, available at [regulation.gov](http://www.regulation.gov). A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would

likely persist; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for GE soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. Without considering mitigation measures on the product label, possible pathways for reaching surface water include field/site runoff, spray drift during application, and vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. Without considering mitigation measures, the major route of exposure to non-target organisms is likely spray drift and runoff. While multiple literature studies show that there is potential for high vapor drift for certain dicamba salts and formulations from soybean fields resulting in non-target plant injury, the available dicamba M1768 formulation volatility research the agency has reviewed indicates that non-target plant biomass and yield will not be affected by use of the M1768 formulation. The assessments, which can be found in the docket for this action, related to these routes of exposure are described in the sections below.

3. Runoff

The agency considered the potential effects due to runoff and developed mitigation to limit off-site runoff that is reflected in the approved labeling for these new uses (e.g., Do not make application of this product if rain is expected in the next 24 hours.). A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

Without consideration of mitigation measures on the approved label, the agency considers spray drift exposure to be the principal risk issue to be considered with these new uses, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following applications of currently registered dicamba products (not containing the same labeling restrictions), likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). The EPA determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. The approved labeling for this action contains these restrictions. Based on the weight of evidence approach, the EPA also determined that labels must include language to maintain an in-field buffer (downwind at the time of application) of 110 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (i.e., NOAEC for soybean plant height). The approved labeling for this action includes these restrictions.

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, and at the time the EPA proposed these new uses, the agency had concerns regarding the volatility of dicamba and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with an additional submission post-proposal that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Based on field volatility (flux) studies (conducted in accordance with the label conditions such as nozzle and ground speed limitations) and laboratory vapor-phase toxicity and exposure (humidome) studies, the 110-foot omnidirectional buffer for volatilization is no longer warranted for the dicamba DGA plus VaporGrip™ (M1768) formulation, because the expected exposure at field's edge is less than the NOAEC for plant risk.

The EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints (plant height and yield) are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (i.e., plant height) for the most sensitive plant species tested (i.e., soybeans), the EPA uses field studies and modeling to determine the distance from site of application to where the NOAEC is not expected to be exceeded. It is further noted that the labels for the new uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and

chronic ($RQ = \text{Exposure}/\text{Toxicity}$). RQs are then compared to the EPA's levels of concern (LOCs). The LOCs are criteria used by the agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOAEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including conventional cotton and soybean. The new uses on GE soybeans and GE cotton expand the timing of applications from only pre-emergence and pre-harvest for soybeans and only pre-emergence and post-harvest for cotton to allowing post-emergence over-the-top applications on these GE crops. The maximum yearly application rates would remain 2.0 lb a.e./A for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./A between pre-emergence and post-emergence applications.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening - level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations at the species-specific level.

The results of the screening-level risk assessments indicate that the RQs do not exceed the agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the agency's LOC. The screening-level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both GE cotton and GE soybeans, based on the new maximum application rates, the screening-

level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, the potential for ecological concerns is related to the potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in GE soybeans. Before considering mitigation measures, the EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening-level assessment, further refinement, as discussed below, suggest that risks are lower and confined to the treated field under the mitigations imposed on the registration. Risks above the level of concern remain for terrestrial plants and animals on the treated field; comparison of the risk to benefits associated with the new use are described in Section VIII.

1. Risk to Birds

For birds, the screening-level assessment (which assumed that 100% of diet is from the treated field) indicated that the RQs exceeded the agency's LOCs on an acute basis for both GE soybean and GE cotton. More specifically, the screening-level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in GE soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming GE soybean forage/hay.

The agency's screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in GE soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs. Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns. This suggests that dicamba consumed in the diet may be less available than assumed using dose-based exposures. Expected field exposure is more likely to be accounted for by the dietary studies that did not indicate risk exceeding levels of concern rather than the acute oral dose studies where risk exceeding thresholds of concern was indicated. As mentioned above, the screening-level analysis assumes that 100% of the diet comes from the treated field which may overestimate total dicamba ingestion.

Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger

concerns for many food items. In addition, estimates of exposure in screening-level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening-level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms that are off the treated field. With this last line of evidence in mind, the pesticide label requires an in-field 110 to 220-foot downwind buffer to eliminate off-site exposure above threshold levels that would trigger risk concern for birds (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for birds feeding on GE plants on the field, and are not expected off the field (since DCSA formation is only a result of dicamba tolerant-plant metabolism).

2.Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the agency’s LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening-level assessment using the maximum exposure values from empirical datasets for DCSA residues in GE soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. The screening-level assessment using the maximum exposure values from empirical data for DCSA residues in GE cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The agency’s screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in GE soybeans and GE cotton plants to determine the RQ values. The EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas. As described in the section for risk to birds, the screening-level assessment assumes that 100% of the diet comes from the treated field.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the pesticide label requires an in-field 110 to 220-foot downwind buffer eliminate off-site exposure above threshold levels that would trigger risk concern for mammals (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for mammals feeding on GE plants on the field, and are not expected off the field.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the new uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift (without mitigation measures), and for dicots in semi-aquatic areas due to runoff and spray drift (without mitigation measures). The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that the approved labeling restrictions will keep the product on the field, thereby reducing spray drift off field. These determinations were made after reviewing additional registrant submitted studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and a change in the formulation to be registered. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1768 Herbicide when an in-field 110 to 220-foot downwind buffer is incorporated between the application equipment and the edges of the treated field. Therefore, potential risks to plants from spray drift is mitigated by requiring a 110-220 foot (depending on application rate) buffer downwind at the time of application.

4. Synergism

The agency views synergism to be a rare event and intends to follow the National Research Council's recommendation for government agencies to proceed with estimating effects of pesticide mixtures with the assumption that the components have additive effects¹ in the absence of any data to support the hypothesis of a synergistic interaction between pesticide active ingredients. However, data is being cited in connection with patent claims submitted to the U.S. Patent and Trademark Office (USPTO) for claims of synergism for specific combinations of dicamba with other herbicides.

The EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings with the USPTO where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. The endpoints in these patent application studies were based on visual observations of weed control and injury, and so were not directly applicable to the EPA's quantitative risk assessment process for plants, in which measures of sub-lethal effects (plant height and weight) serve as sensitive effects thresholds for risk estimation purposes. The EPA believes this quantitative

¹ The phrase 'additive effects' is used when the effect of the combination of chemicals can be estimated directly from the sum of the scaled exposure levels (dose addition) or of the responses (response addition) of the individual components.

approach is very reliable for the purpose of potential toxicity to plants.

The agency is continuing its work with that information in order to better understand the scope of these uncertainties for these specific combinations and to develop an approach that best manages the potential risks while still maintaining the important benefits derived from tank mixing. While evaluation of these data are still in progress, the agency is requiring that the end-use product label allow only tank mixing with other herbicides in combinations that have not been granted patents for synergistic behavior at the time of this registration. For prohibited combinations, if the EPA determines that sufficient data do not exist to support synergistic effects with a particular active ingredient, or if the agency has evaluated data that is more directly applicable to the agency's quantitative risk assessment process for plants that demonstrates that no increased toxicity to plants exists and are therefore not of concern, that ingredient may then be allowed in tank mix combinations. A list of acceptable tank mixes will be maintained by Monsanto on their already established website, www.xtendimaxapplicationrequirements.com

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this final decision.

In the screening-level risk assessment performed for the new application timing of dicamba (DGA) on GE cotton and GE soybean to be resistant to dicamba, the EPA determined that levels of concern were not exceeded for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on GE seeds to be resistant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at [species/ecological-risk-assessment-process-under-endangered-species-act](http://www.epa.gov/species/ecological-risk-assessment-process-under-endangered-species-act)]. That assessment uses broad default assumptions to establish estimated

environmental concentrations of particular pesticides. If the screening-level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, the EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. The EPA determines that there is “no effect” on listed species if, at any step in the screening-level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening-level assessment, a pesticide still exceeds the agency’s levels of concern for listed species, the EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening-level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening-level risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to the EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening-level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a No Effect determination is identified for the corresponding taxon.

This registration for dicamba has been finalized for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an acceptable assessment of listed species is completed for any such state.

Based on the EPA’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), the EPA identified the listed species that are inside the “action area” (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 34 states.

The following criteria are used to make a species-specific effects determination:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY EFFECT categories depending upon their specific biological needs and circumstances of exposure.
- Those that fall under the MAY EFFECT category are found to be either LIKELY or NOT LIKELY TO ADVERSELY AFFECT the listed species.
A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial
- A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift label mitigation language including an in-field spray drift buffer of 110 feet (for the 0.5 lb/A rate) and 220 feet (for the 1.0 lb/A rate) downwind at the time of application is expected to limit off site transport of dicamba DGA through spray drift. Therefore, the EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, the EPA concluded a NO EFFECT determination for all but 24 species originally identified as potentially at-risk (in the screening-level assessment) because they are not expected to occur on cotton and soybean fields.

The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in the EPA's refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, the EPA made a determination that exposure occurring on the field would have "may affects" (either "unlikely to adversely affect" or "likely to adversely affect" on 3 species (the Eskimo Curlew, the Spring Creek Bladderpod in Wilson county, TN, and the Audubon Crested Caracara in Palm Beach county, FL) within the States covered by this final decision. The EPA initiated informal consultation with the U.S. Fish and Wildlife Service (FWS) for the Eskimo curlew. The FWS concurred with the "unlikely to adversely affect" determination and no further action need be taken relative to this species. Furthermore, to address the remaining effects, the registrant submitted revised labeling and the EPA approved the labeling that prohibits application in both Wilson county, TN and Palm Beach county, FL. Therefore, the EPA makes no effect determinations for all listed species that are expected to be on the treated fields.

Additionally, the agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, the EPA's analysis also supports a no effects determination for runoff exposure for off-field listed plants for the new labeled use of dicamba DGA. To further protect species off the treated field against runoff, rainfast mitigation is required on the label ("Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.").

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on GE crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, the EPA is requiring, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a lack of performance can obtain direct support from Monsanto through a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, the EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the new uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and

contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers' permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to the EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15, 2018, on or before January 15th of each year thereafter, Monsanto must submit annual summary reports to the EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the final dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for the EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The agency received 21,710 comments in response to the public participation process (Docket ID: the EPA-HQ-OPP-2016-0187) regarding the EPA's proposed decision for the application to register the use of dicamba on GE cotton and GE soybeans. Comments received were both in favor of and opposed to the decision to register the new uses which will provide growers with additional tools to control broadleaf weeds. The EPA welcomes input from the public during the decision process when registering significant new uses, and is committed to reviewing the comments received and determining whether changes or further mitigation are necessary to meet the applicable statutory standards. The EPA reviewed and evaluated the comments received during the comment period before issuing this final regulatory decision. Since many of the comments covered similar concerns, the comments were grouped into major topic areas. Please see *Response to Public Comments Received Regarding the New Use of Dicamba on Dicamba-Tolerant Cotton and Soybeans* dated November 7, 2016 for the agency's response to these comments.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest

management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Previously registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the previously registered uses of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba will expand weed management options on GE cotton and GE soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season will target new flushes of weeds, thereby reducing populations of these weeds and particularly will help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Registration Decision

In accordance with FIFRA, the EPA only registers a pesticide when it finds that the use will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, the EPA is charged with balancing the uncertainties and risks posed by a pesticide against the benefits associated with the use of the pesticide. The EPA must determine if the benefits in light of its use outweigh the risks in order for the agency to register a pesticide.

In the case for the new uses of dicamba on GE soybeans and GE cotton, and in consideration of all best available data and assessment methods, the EPA determines that its decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered complete and adequate to evaluate risks to infants and children. The agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some LOCs were exceeded for certain birds, reptiles, amphibians, and mammals that may be in the treated fields. These assessments included conservative risk estimates using screening-level (worst case) assumptions that are unlikely to apply to the majority of the birds, reptiles, amphibians, and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated field. Because of these additional restrictions, the EPA expects these uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the agency's levels of concern.

On the benefits side of the analysis, use of dicamba on GE soybeans and GE cotton is expected to become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed

and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of the United States soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states in the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on GE soybeans and GE cotton is beneficial as it provides an effective tool to treat especially noxious weeds, such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba can help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to GE soybean and GE cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the approved labeling restrictions will include further beneficial protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

The EPA finds these benefits important. Furthermore, this regulatory decision includes a number of requirements that are expected to effectively limit concerns for off field risk. This registration action is only for a product confirmed by data to be a lower volatility formulation. In addition, the label requires very specific and rigorous drift mitigation measures, including in-field buffers, aerial application prohibitions, boom height requirements, specific nozzle and spray pressure requirements, and wind and tractor speed limitations. These mitigations are known to profoundly impact any drift potential from pesticide application. In aggregate, these formulations and labeling requirements are expected to eliminate any offsite exposures and effectively prevent risk potential to people and non-target species.

After weighing all the risks of concern against the benefits of the new uses, the EPA finds that when the mitigation measures for these uses are applied, the benefits of the use of the pesticide outweighs any remaining minimal risks, if they exist at all. Therefore, registering these new uses will not generally cause unreasonable adverse effects on human health or the environment. the EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(7)(B) registration finding for the new uses. Although the EPA proposed registering dicamba under FIFRA section 3(c)(5), new data requirements have been identified through registration review that will be applicable to all dicamba products (and all uses), therefore the agency is registering these new uses under FIFRA section 3(c)(7)(B).

A. Data Requirements

Although there are currently no outstanding data require to support the final registration of this action, the EPA has identified data that will be required in connection with Registration Review activities for dicamba. Those requirements will be applicable to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the final supplemental labels unless otherwise noted below.

1. Worker Protection

(Although the following Worker Protection labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on May 1, 2014 for this product.)

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. Environmental Hazards

(Although the following Environmental Hazards labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on September 18, 2013 for this product.)

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1768 Herbicide for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call 1-844-RRXTEND.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season,
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use only Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying XtendiMax™ With VaporGrip™ Technology or any other approved nozzle found at www.xtendimaxapplicationrequirements.com. Do not use any other nozzle and pressure combination not specifically listed on this website. www.xtendimaxapplicationrequirements.com

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity or temperatures above 91 degrees Fahrenheit, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and can be impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Do not apply this product during a temperature inversion. Off-target movement potential can be high during a temperature inversion. During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on evenings and nights with limited cloud cover and light to no wind. Cooling of air at the earth's surface takes place and warmer air is trapped above it. They can begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing. The inversion will often dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

Buffer

Maintain a 110 foot downwind buffer (when applying 22 fluid ounces of this product per acre) or a 220 foot downwind buffer (when applying 44 fluid ounces of this product per acre) between the last treated row and the closest downwind edge (in the direction in which the wind is blowing). If any of the following areas below are directly adjacent to the treated field, the areas listed below can be considered part of the buffer distance.

To maintain this required buffer zone:

- No application swath can be initiated in, or into an area that is within the applicable buffer distance.

The following areas may be included in the buffer distance calculation when adjacent to field edges:

- Roads, paved or gravel surfaces.
- Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, sorghum, proso millet, small grains and sugarcane. If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant and not conventional cotton and/or soybeans.
- Agricultural fields that have been prepared for planting.
- Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1768 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1768 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.
- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans per year.
- The combined total application rate from crop emergence up to 7 days' pre-harvest must not exceed 88 fluid ounce (2.0lb a.e dicamba) per acre for cotton per year.
- All applications for both cotton and soybeans must not exceed 88 fluid ounces (2.0 lb a.e dicamba) per acre per year.

C. Registration Terms

The EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. The EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. The EPA is basing the final registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., "Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations," *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

The EPA is issuing this registration with a term that requires Monsanto to have an Herbicide Resistance Management (HRM) Plan for M1768 Herbicide. The HRM Plan will focus on educating growers on the appropriate use of the M1768 Herbicide and the associated dicamba-tolerant seeds. The EPA is requiring that the HRM plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

The EPA is requiring that Monsanto or its representative investigate reports of lack of herbicide efficacy as reported by users following "scouting." When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for

“likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures. Additionally, Monsanto must routinely collect plant material for further testing.

c. Annual Reporting of Herbicide Resistance to the EPA

Monsanto must submit annual summary reports to the EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

D. Registration Expiration

The issue of weed resistance is an extremely important issue to keep under control and can be very fast moving. Also, the EPA is aware of reports of off-site incidents potentially due to the illegal use of dicamba products that do not employ the lower volatility formulation of dicamba DGA plus VaporGrip™ (M-1768) on GE cotton and GE soybean. Although the EPA finds that herbicide resistance is adequately addressed by the required herbicide resistance plan and does not expect off-site incidents to occur due to the specific measures required (described above) to this registration, the agency is requiring expiration dates that will ensure that the EPA retains the ability to easily modify the registration or allow the registration to terminate if necessary.

Specifically, this registration automatically expires on November 9, 2018, unless the EPA determines before that date that off-site incidents are not occurring at unacceptable frequencies or levels. If this automatic expiration date is amended (in whatever way the EPA determines is appropriate at the time), it shall not be amended to a date later than November 9, 2021, by which date this registration will automatically expire unless the EPA determines before that date that

herbicide resistance to dicamba is not occurring at unacceptable frequencies or levels, and that off-site incidents are not occurring at unacceptable frequencies or levels.

E. Geographic Limitation on Use of Dicamba M1768 Herbicide

The EPA is issuing these new uses only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62. <http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>

CERTIFICATE OF SERVICE

I am over eighteen years of age and not a party to this action. I am employed in the county where the mailing took place. My business address is 303 Sacramento Street, 2nd Floor, San Francisco, CA 94111.

I hereby certify that on January 20, 2017, I caused to be served one true and correct copy of the **PETITION FOR REVIEW and CORPORATE**

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Legal Assistant



Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

A handwritten signature in black ink is written over the signature line. The signature is cursive and appears to read "J. E. Housenger".

Jack E. Housenger, Director
Office of Pesticide Programs

Date: _____

A handwritten date "11/9/16" is written in black ink over the date line. The numbers are written in a simple, slightly slanted font.

Summary

This document announces that the U.S. Environmental Protection Agency (the EPA or the agency) has granted a conditional registration under Section 3(c)(7)(B) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba for use on genetically-engineered (GE) cotton and GE soybean that have been engineered to be resistant to dicamba in the following states: Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

These new dicamba uses were originally proposed by the Monsanto Company to be added to the currently registered herbicide product M1691 (the EPA Registration Number 524-582). This is the specific formulation that was listed in the agency's Proposed Decision released for public comment earlier this year. Since the proposed decision was published, the agency also assessed a lower volatility dicamba formulation (M1768, with the brand name Xtendimax™ with VaporGrip™ Technology, the EPA Registration Number 524-617). the EPA expects the lower volatility formulation to further reduce the potential off site movement of generic dicamba formulations and is included in today's regulatory decision.

The M1768 product contains the same active ingredient as M1691, diglycolamine (DGA) salt of dicamba, and is to be used with equivalent application rates and the same application techniques. Because the two products contain the same active ingredient used at the same rates with the same methods, all of the environmental and human health assessments completed and made public in connection with the proposed registration decision for the M1691 apply to M1768. After assessing volatility studies conducted on the M1768 formulation (discussed later in this document), the EPA has determined that the new lower volatility formulation of M1768 offers the user a product with less potential to volatilize and move off the target area. The volatility analysis is included in the docket for this final decision. Therefore, the new uses were granted for the M1768 formulation.

This final decision document discusses several agency considerations of the new uses for dicamba on GE soybean and GE cotton, including discussions of human health and environmental risks associated with the new uses as well as the benefits associated with these uses. the EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the assessment for human health included the N, N-Bis-(3-aminopropyl) methylamine (BAPMA) salt of dicamba (M1768 contains the DGA salt of dicamba) because the data on the BAPMA salt was relevant to the analysis and presented the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. But, when product specific considerations were necessary for the analysis, the EPA reviewed the effects of the DGA salt. For example, to determine appropriate spray drift buffers, the agency examined drift potential using studies conducted on the DGA salt formulation.

Under the Plant Protection Act, the United States Department of Agriculture (USDA) deregulated the GE cotton and GE soybean seeds tolerant to dicamba on January 15, 2015.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Product: M1768 Herbicide (Xtendimax™ with VaporGrip™ Technology) EPA Registration Number 524-617

Background

On April 28, 2010 and July 30, 2012, respectively, the EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on GE soybean and GE cotton. The application also requested the establishment of new tolerances for residues resulting from the new uses. The tolerances for these new uses have been established.

Dicamba is an active ingredient that is currently used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The new uses will expand the current timing of dicamba applications to post-emergence (over-the-top) applications to GE cotton and GE soybean crops. Until this registration, dicamba was only registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. It is important to note that using registered dicamba products on GE cotton or GE soybean crops that are not registered specifically for post-emergence use on GE cotton or GE soybean crops is inconsistent with the pesticide's labeling and a violation of FIFRA.

New Uses

Cotton

Dicamba products that are currently registered on conventional cotton are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.25 to 1.0 pounds acid equivalent (lb a.e.) dicamba per acre. The maximum annual application for all preplant, at planting and pre-emergence applications combined on conventional cotton is 1.0 lb a.e. dicamba per acre per season.

For the new use, for post-emergence (in-crop) application of dicamba for use on GE cotton, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total of all in-crop applications for GE cotton is 88 fluid ounces (2.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, and pre-emergence treatments to GE cotton, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, and pre-emergence applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications (preplant, at-planting, pre-emergence and post-emergence (in-crop) must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. For example, if a preplant application of 44 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for GE cotton.

The minimum retreatment interval is 7 days; the pre-harvest interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

Dicamba products that are currently registered on conventional soybeans are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.125 to 0.5 pounds acid equivalent (lb a.e.) dicamba per acre and for preharvest burndown treatments at 0.25 to 1.0 lb a.e. dicamba per acre. The maximum annual application for all preplant, at planting, pre-emergence, and preharvest burndown applications combined on conventional soybeans is 1.0 lb a.e. dicamba per acre per season.

For the new use for post-emergence (in-crop) application of this product to GE soybeans, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total for all in-crop applications for GE soybeans is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, pre-emergence, and preharvest burndown treatments to GE soybeans, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, pre-emergence, and preharvest applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay, is 14 days (R1 Growth stage).

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human

health risk assessment for dicamba, risks were assessed in a manner that protects human health from exposure to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data show greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, the EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. The EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, the EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the agency assumes that any amount of exposure will lead to some degree of risk. Thus, the agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be "not likely" to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles the EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2)

- more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. Since the BAPMA salt shows increased toxicity via inhalation, the BAPMA was included in the aggregate risk assessment. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment for these new uses. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The agency determined, based on review of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, the EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, the EPA assumes that any amount of exposure will lead to some degree of risk. Thus, the EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity

study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainly factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and as discussed in Section C below, 1X for FQPA SF when applicable). The inhalation HEC results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined, and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite lacked findings of carcinogenicity in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

The EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) There is no evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (i) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (ii) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (iii) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerance levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models (e.g., models using screening level assumptions). Therefore, the agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

The EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other

substances. Therefore, the EPA finds for this decision that dicamba does not have a common mechanism of toxicity with other substances. For information regarding the EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by the EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on the EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities. Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with the EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the POD for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and new uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the agency's LOC for both food and water. For the U.S. population, the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting

residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being established for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to the agency's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

Since dicamba products registered for use on residential turf come in both liquid and granular

formulations, both are accounted for in this assessment. The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application Inhalation Exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the new uses of dicamba on GE corn and GE soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. In general, volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40-acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Although a more recent volatility study conducted using the M1768 formulation was submitted and reviewed, which demonstrated comparable potential for volatility as described in greater detail in the document entitled *Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton* available in the docket for this action, that study was not available at the time this Human Health assessment was developed. Results of PERFUM modeling using the Bradenton, FL study however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates for potential human bystander exposure are not of concern.

4. Spray Drift

Without considering mitigation measures, it is reasonable to assume that spray drift may be a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The maximum single application rate of dicamba for this new use is 1 lb a.e./A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. This spray drift fraction estimation differs from that used for environmental exposures because, unlike environmental risk assessment that uses estimations to determine exposures at the edge of the treated field, estimations for human health risk assessment are used to assess the average deposition over a wide area of lawn. For the purposes of the new uses on dicamba, this is considered a screening level assumption since the new use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate of 1 lb a.e./A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the Federal Food, Drug, and Cosmetic Act (FFDCA), the EPA must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be

aggregated. When aggregating exposures and risks from various sources, the EPA considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- or long-term durations via the oral, dermal, or inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and new use sites. Drinking water values were incorporated directly into the assessment. The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term Aggregate Risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short-term aggregate risks.

c. Long-term Aggregate Risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant percent crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

6. Occupational Risk Assessment

a. Short- and Intermediate-term Handler Risk

The EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on GE cotton and GE soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short- and Intermediate-term Post-application Risk

The EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard via the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation Post Application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on GE soybean and GE cotton is provided below. More detailed discussions can be found in the agency documents titled:

- *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708) and*
- *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701), and its addendums entitled,*
- *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean and*
- *Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean and*
- *M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide, EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton.*

These documents are in docket number EPA-HQ-OPP-2016-0187, available at regulation.gov. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would

likely persist; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for GE soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. Without considering mitigation measures on the product label, possible pathways for reaching surface water include field/site runoff, spray drift during application, and vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degrade of dicamba, DCSA, is persistent under anaerobic conditions; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. Without considering mitigation measures, the major route of exposure to non-target organisms is likely spray drift and runoff. While multiple literature studies show that there is potential for high vapor drift for certain dicamba salts and formulations from soybean fields resulting in non-target plant injury, the available dicamba M1768 formulation volatility research the agency has reviewed indicates that non-target plant biomass and yield will not be affected by use of the M1768 formulation. The assessments, which can be found in the docket for this action, related to these routes of exposure are described in the sections below.

3. Runoff

The agency considered the potential effects due to runoff and developed mitigation to limit off-site runoff that is reflected in the approved labeling for these new uses (e.g., Do not make application of this product if rain is expected in the next 24 hours.). A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

Without consideration of mitigation measures on the approved label, the agency considers spray drift exposure to be the principal risk issue to be considered with these new uses, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following applications of currently registered dicamba products (not containing the same labeling restrictions), likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). The EPA determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. The approved labeling for this action contains these restrictions. Based on the weight of evidence approach, the EPA also determined that labels must include language to maintain an in-field buffer (downwind at the time of application) of 110 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (i.e., NOAEC for soybean plant height). The approved labeling for this action includes these restrictions.

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, and at the time the EPA proposed these new uses, the agency had concerns regarding the volatility of dicamba and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with an additional submission post-proposal that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Based on field volatility (flux) studies (conducted in accordance with the label conditions such as nozzle and ground speed limitations) and laboratory vapor-phase toxicity and exposure (humidome) studies, the 110-foot omnidirectional buffer for volatilization is no longer warranted for the dicamba DGA plus VaporGrip™ (M1768) formulation, because the expected exposure at field's edge is less than the NOAEC for plant risk.

The EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints (plant height and yield) are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (i.e., plant height) for the most sensitive plant species tested (i.e., soybeans), the EPA uses field studies and modeling to determine the distance from site of application to where the NOAEC is not expected to be exceeded. It is further noted that the labels for the new uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and

chronic ($RQ = \text{Exposure}/\text{Toxicity}$). RQs are then compared to the EPA's levels of concern (LOCs). The LOCs are criteria used by the agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOAEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including conventional cotton and soybean. The new uses on GE soybeans and GE cotton expand the timing of applications from only pre-emergence and pre-harvest for soybeans and only pre-emergence and post-harvest for cotton to allowing post-emergence over-the-top applications on these GE crops. The maximum yearly application rates would remain 2.0 lb a.e./A for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./A between pre-emergence and post-emergence applications.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening - level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations at the species-specific level.

The results of the screening-level risk assessments indicate that the RQs do not exceed the agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the agency's LOC. The screening-level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both GE cotton and GE soybeans, based on the new maximum application rates, the screening-

level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, the potential for ecological concerns is related to the potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in GE soybeans. Before considering mitigation measures, the EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening-level assessment, further refinement, as discussed below, suggest that risks are lower and confined to the treated field under the mitigations imposed on the registration. Risks above the level of concern remain for terrestrial plants and animals on the treated field; comparison of the risk to benefits associated with the new use are described in Section VIII.

1. Risk to Birds

For birds, the screening-level assessment (which assumed that 100% of diet is from the treated field) indicated that the RQs exceeded the agency's LOCs on an acute basis for both GE soybean and GE cotton. More specifically, the screening-level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in GE soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming GE soybean forage/hay.

The agency's screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in GE soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs. Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns. This suggests that dicamba consumed in the diet may be less available than assumed using dose-based exposures. Expected field exposure is more likely to be accounted for by the dietary studies that did not indicate risk exceeding levels of concern rather than the acute oral dose studies where risk exceeding thresholds of concern was indicated. As mentioned above, the screening-level analysis assumes that 100% of the diet comes from the treated field which may overestimate total dicamba ingestion.

Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger

concerns for many food items. In addition, estimates of exposure in screening-level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening-level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms that are off the treated field. With this last line of evidence in mind, the pesticide label requires an in-field 110 to 220-foot downwind buffer to eliminate off-site exposure above threshold levels that would trigger risk concern for birds (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for birds feeding on GE plants on the field, and are not expected off the field (since DCSA formation is only a result of dicamba tolerant-plant metabolism).

2.Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the agency’s LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening-level assessment using the maximum exposure values from empirical datasets for DCSA residues in GE soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. The screening-level assessment using the maximum exposure values from empirical data for DCSA residues in GE cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The agency’s screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in GE soybeans and GE cotton plants to determine the RQ values. The EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas. As described in the section for risk to birds, the screening-level assessment assumes that 100% of the diet comes from the treated field.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the pesticide label requires an in-field 110 to 220-foot downwind buffer eliminate off-site exposure above threshold levels that would trigger risk concern for mammals (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for mammals feeding on GE plants on the field, and are not expected off the field.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the new uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift (without mitigation measures), and for dicots in semi-aquatic areas due to runoff and spray drift (without mitigation measures). The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that the approved labeling restrictions will keep the product on the field, thereby reducing spray drift off field. These determinations were made after reviewing additional registrant submitted studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and a change in the formulation to be registered. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1768 Herbicide when an in-field 110 to 220-foot downwind buffer is incorporated between the application equipment and the edges of the treated field. Therefore, potential risks to plants from spray drift is mitigated by requiring a 110-220 foot (depending on application rate) buffer downwind at the time of application.

4. Synergism

The agency views synergism to be a rare event and intends to follow the National Research Council's recommendation for government agencies to proceed with estimating effects of pesticide mixtures with the assumption that the components have additive effects¹ in the absence of any data to support the hypothesis of a synergistic interaction between pesticide active ingredients. However, data is being cited in connection with patent claims submitted to the U.S. Patent and Trademark Office (USPTO) for claims of synergism for specific combinations of dicamba with other herbicides.

The EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings with the USPTO where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. The endpoints in these patent application studies were based on visual observations of weed control and injury, and so were not directly applicable to the EPA's quantitative risk assessment process for plants, in which measures of sub-lethal effects (plant height and weight) serve as sensitive effects thresholds for risk estimation purposes. The EPA believes this quantitative

¹ The phrase 'additive effects' is used when the effect of the combination of chemicals can be estimated directly from the sum of the scaled exposure levels (dose addition) or of the responses (response addition) of the individual components.

approach is very reliable for the purpose of potential toxicity to plants.

The agency is continuing its work with that information in order to better understand the scope of these uncertainties for these specific combinations and to develop an approach that best manages the potential risks while still maintaining the important benefits derived from tank mixing. While evaluation of these data are still in progress, the agency is requiring that the end-use product label allow only tank mixing with other herbicides in combinations that have not been granted patents for synergistic behavior at the time of this registration. For prohibited combinations, if the EPA determines that sufficient data do not exist to support synergistic effects with a particular active ingredient, or if the agency has evaluated data that is more directly applicable to the agency's quantitative risk assessment process for plants that demonstrates that no increased toxicity to plants exists and are therefore not of concern, that ingredient may then be allowed in tank mix combinations. A list of acceptable tank mixes will be maintained by Monsanto on their already established website, www.xtendimaxapplicationrequirements.com

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this final decision.

In the screening-level risk assessment performed for the new application timing of dicamba (DGA) on GE cotton and GE soybean to be resistant to dicamba, the EPA determined that levels of concern were not exceeded for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degrade from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on GE seeds to be resistant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at [species/ecological-risk-assessment-process-under-endangered-species-act](http://www.epa.gov/species/ecological-risk-assessment-process-under-endangered-species-act)]. That assessment uses broad default assumptions to establish estimated

environmental concentrations of particular pesticides. If the screening-level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, the EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. The EPA determines that there is “no effect” on listed species if, at any step in the screening-level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening-level assessment, a pesticide still exceeds the agency’s levels of concern for listed species, the EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening-level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening-level risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to the EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening-level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a No Effect determination is identified for the corresponding taxon.

This registration for dicamba has been finalized for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an acceptable assessment of listed species is completed for any such state.

Based on the EPA’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), the EPA identified the listed species that are inside the “action area” (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 34 states.

The following criteria are used to make a species-specific effects determination:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY EFFECT categories depending upon their specific biological needs and circumstances of exposure.
- Those that fall under the MAY EFFECT category are found to be either LIKELY or NOT LIKELY TO ADVERSELY AFFECT the listed species.
A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial
- A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift label mitigation language including an in-field spray drift buffer of 110 feet (for the 0.5 lb/A rate) and 220 feet (for the 1.0 lb/A rate) downwind at the time of application is expected to limit off site transport of dicamba DGA through spray drift. Therefore, the EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, the EPA concluded a NO EFFECT determination for all but 24 species originally identified as potentially at-risk (in the screening-level assessment) because they are not expected to occur on cotton and soybean fields.

The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in the EPA's refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, the EPA made a determination that exposure occurring on the field would have "may affects" (either "unlikely to adversely affect" or "likely to adversely affect" on 3 species (the Eskimo Curlew, the Spring Creek Bladderpod in Wilson county, TN, and the Audubon Crested Caracara in Palm Beach county, FL) within the States covered by this final decision. The EPA initiated informal consultation with the U.S. Fish and Wildlife Service (FWS) for the Eskimo curlew. The FWS concurred with the "unlikely to adversely affect" determination and no further action need be taken relative to this species. Furthermore, to address the remaining effects, the registrant submitted revised labeling and the EPA approved the labeling that prohibits application in both Wilson county, TN and Palm Beach county, FL. Therefore, the EPA makes no effect determinations for all listed species that are expected to be on the treated fields.

Additionally, the agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, the EPA's analysis also supports a no effects determination for runoff exposure for off-field listed plants for the new labeled use of dicamba DGA. To further protect species off the treated field against runoff, rainfast mitigation is required on the label ("Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.").

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on GE crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, the EPA is requiring, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a lack of performance can obtain direct support from Monsanto through a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, the EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the new uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and

contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers' permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to the EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15, 2018, on or before January 15th of each year thereafter, Monsanto must submit annual summary reports to the EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the final dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for the EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The agency received 21,710 comments in response to the public participation process (Docket ID: the EPA-HQ-OPP-2016-0187) regarding the EPA's proposed decision for the application to register the use of dicamba on GE cotton and GE soybeans. Comments received were both in favor of and opposed to the decision to register the new uses which will provide growers with additional tools to control broadleaf weeds. The EPA welcomes input from the public during the decision process when registering significant new uses, and is committed to reviewing the comments received and determining whether changes or further mitigation are necessary to meet the applicable statutory standards. The EPA reviewed and evaluated the comments received during the comment period before issuing this final regulatory decision. Since many of the comments covered similar concerns, the comments were grouped into major topic areas. Please see *Response to Public Comments Received Regarding the New Use of Dicamba on Dicamba-Tolerant Cotton and Soybeans* dated November 7, 2016 for the agency's response to these comments.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest

management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Previously registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the previously registered uses of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba will expand weed management options on GE cotton and GE soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season will target new flushes of weeds, thereby reducing populations of these weeds and particularly will help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Registration Decision

In accordance with FIFRA, the EPA only registers a pesticide when it finds that the use will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, the EPA is charged with balancing the uncertainties and risks posed by a pesticide against the benefits associated with the use of the pesticide. The EPA must determine if the benefits in light of its use outweigh the risks in order for the agency to register a pesticide.

In the case for the new uses of dicamba on GE soybeans and GE cotton, and in consideration of all best available data and assessment methods, the EPA determines that its decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered complete and adequate to evaluate risks to infants and children. The agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some LOCs were exceeded for certain birds, reptiles, amphibians, and mammals that may be in the treated fields. These assessments included conservative risk estimates using screening-level (worst case) assumptions that are unlikely to apply to the majority of the birds, reptiles, amphibians, and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated field. Because of these additional restrictions, the EPA expects these uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the agency's levels of concern.

On the benefits side of the analysis, use of dicamba on GE soybeans and GE cotton is expected to become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed

and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of the United States soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states in the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on GE soybeans and GE cotton is beneficial as it provides an effective tool to treat especially noxious weeds, such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba can help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to GE soybean and GE cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the approved labeling restrictions will include further beneficial protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

The EPA finds these benefits important. Furthermore, this regulatory decision includes a number of requirements that are expected to effectively limit concerns for off field risk. This registration action is only for a product confirmed by data to be a lower volatility formulation. In addition, the label requires very specific and rigorous drift mitigation measures, including in-field buffers, aerial application prohibitions, boom height requirements, specific nozzle and spray pressure requirements, and wind and tractor speed limitations. These mitigations are known to profoundly impact any drift potential from pesticide application. In aggregate, these formulations and labeling requirements are expected to eliminate any offsite exposures and effectively prevent risk potential to people and non-target species.

After weighing all the risks of concern against the benefits of the new uses, the EPA finds that when the mitigation measures for these uses are applied, the benefits of the use of the pesticide outweighs any remaining minimal risks, if they exist at all. Therefore, registering these new uses will not generally cause unreasonable adverse effects on human health or the environment. the EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(7)(B) registration finding for the new uses. Although the EPA proposed registering dicamba under FIFRA section 3(c)(5), new data requirements have been identified through registration review that will be applicable to all dicamba products (and all uses), therefore the agency is registering these new uses under FIFRA section 3(c)(7)(B).

A. Data Requirements

Although there are currently no outstanding data require to support the final registration of this action, the EPA has identified data that will be required in connection with Registration Review activities for dicamba. Those requirements will be applicable to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the final supplemental labels unless otherwise noted below.

1. Worker Protection

(Although the following Worker Protection labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on May 1, 2014 for this product.)

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. Environmental Hazards

(Although the following Environmental Hazards labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on September 18, 2013 for this product.)

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1768 Herbicide for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call 1-844-RRXTEND.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season,
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use only Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying XtendiMax™ With VaporGrip™ Technology or any other approved nozzle found at www.xtendimaxapplicationrequirements.com. Do not use any other nozzle and pressure combination not specifically listed on this website. www.xtendimaxapplicationrequirements.com

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity or temperatures above 91 degrees Fahrenheit, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and can be impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Do not apply this product during a temperature inversion. Off-target movement potential can be high during a temperature inversion. During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on evenings and nights with limited cloud cover and light to no wind. Cooling of air at the earth's surface takes place and warmer air is trapped above it. They can begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing. The inversion will often dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

Buffer

Maintain a 110 foot downwind buffer (when applying 22 fluid ounces of this product per acre) or a 220 foot downwind buffer (when applying 44 fluid ounces of this product per acre) between the last treated row and the closest downwind edge (in the direction in which the wind is blowing). If any of the following areas below are directly adjacent to the treated field, the areas listed below can be considered part of the buffer distance.

To maintain this required buffer zone:

- No application swath can be initiated in, or into an area that is within the applicable buffer distance.

The following areas may be included in the buffer distance calculation when adjacent to field edges:

- Roads, paved or gravel surfaces.
- Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, sorghum, proso millet, small grains and sugarcane. If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant and not conventional cotton and/or soybeans.
- Agricultural fields that have been prepared for planting.
- Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1768 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1768 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.
- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans per year.
- The combined total application rate from crop emergence up to 7 days' pre-harvest must not exceed 88 fluid ounce (2.0lb a.e dicamba) per acre for cotton per year.
- All applications for both cotton and soybeans must not exceed 88 fluid ounces (2.0 lb a.e dicamba) per acre per year.

C. Registration Terms

The EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. The EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. The EPA is basing the final registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., "Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations," *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

The EPA is issuing this registration with a term that requires Monsanto to have an Herbicide Resistance Management (HRM) Plan for M1768 Herbicide. The HRM Plan will focus on educating growers on the appropriate use of the M1768 Herbicide and the associated dicamba-tolerant seeds. The EPA is requiring that the HRM plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

The EPA is requiring that Monsanto or its representative investigate reports of lack of herbicide efficacy as reported by users following "scouting." When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for

“likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures. Additionally, Monsanto must routinely collect plant material for further testing.

c. Annual Reporting of Herbicide Resistance to the EPA

Monsanto must submit annual summary reports to the EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

D. Registration Expiration

The issue of weed resistance is an extremely important issue to keep under control and can be very fast moving. Also, the EPA is aware of reports of off-site incidents potentially due to the illegal use of dicamba products that do not employ the lower volatility formulation of dicamba DGA plus VaporGrip™ (M-1768) on GE cotton and GE soybean. Although the EPA finds that herbicide resistance is adequately addressed by the required herbicide resistance plan and does not expect off-site incidents to occur due to the specific measures required (described above) to this registration, the agency is requiring expiration dates that will ensure that the EPA retains the ability to easily modify the registration or allow the registration to terminate if necessary.

Specifically, this registration automatically expires on November 9, 2018, unless the EPA determines before that date that off-site incidents are not occurring at unacceptable frequencies or levels. If this automatic expiration date is amended (in whatever way the EPA determines is appropriate at the time), it shall not be amended to a date later than November 9, 2021, by which date this registration will automatically expire unless the EPA determines before that date that

herbicide resistance to dicamba is not occurring at unacceptable frequencies or levels, and that off-site incidents are not occurring at unacceptable frequencies or levels.

E. Geographic Limitation on Use of Dicamba M1768 Herbicide

The EPA is issuing these new uses only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62. <http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>



Proposed Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

Jack Housenger, Director
Office of Pesticide Programs

Date: 3/31/16

Summary

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing to grant an unconditional registration under Section 3(c)(5) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba on genetically-modified dicamba-tolerant cotton and genetically-modified dicamba-tolerant soybean. The proposed new uses will be added to the currently registered herbicide product M1691 (EPA Registration Number 524-582), containing 58.1% of the active ingredient dicamba, diglycolamine salt (DGA) for pre- and post-emergence (in-crop) applications to dicamba-tolerant cotton and soybean.

The U.S. Department of Agriculture (USDA) granted deregulation status for dicamba-tolerant cotton and soybean on January 15, 2015 under the Plant Protection Act.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Proposed Product: M1691 Herbicide

Background

On April 28, 2010 and July 30, 2012, respectively, EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on genetically-modified dicamba -tolerant soybean and cotton.

Dicamba is an active ingredient that is used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The proposed new uses on cotton and soybeans would expand the current timing of dicamba applications to dicamba-tolerant soybeans and cotton. Dicamba is currently registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. The proposed use would add post-emergence (over-the-top) applications to dicamba-tolerant cotton and soybean crops.

Dicamba is a member of the Benzoic acid family of herbicides (Herbicide Resistance Action Committee (HRAC) Group 4). Dicamba works by increasing plant growth rate. Once sufficient concentration is reached, the plant outgrows its own nutrient supplies and ultimately dies.

This proposal discusses several Agency considerations of the proposed use for dicamba on dicamba-tolerant soybeans and cotton, including discussions of human health and environmental risks associated with the proposed uses. Due to the multiple forms of dicamba, EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the

assessment for human health considered data associated with the BAPMA salt of dicamba, even though this registration action is being proposed for a formulation containing only the DGA salt of dicamba. This is because the data on the BAPMA salt was relevant to the analysis and resulted in the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. On the other hand, assessments focus on effects of the DGA salt when product specific considerations are discussed. For example, to determine appropriate spray drift buffers, the Agency examined drift potential using studies conducted on the DGA salt formulation.

Proposed New Uses

Cotton

On currently registered dicamba products for use on conventional cotton, pre-emergence treatment can be made at 8 fluid ounces (0.25 lb a.e. dicamba) per acre per season. The maximum single/annual application rate proposed for use on dicamba-tolerant cotton for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use, for post-emergence (in-crop) application of dicamba for use on dicamba-tolerant cotton, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in dicamba-tolerant cotton is 64 fluid ounces (2.0 lb a.e. dicamba) per acre.

If a preplant application of 32 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for dicamba-tolerant cotton.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest retreatment interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

On currently registered dicamba products, the maximum single and maximum annual application rate allowed to both conventional and dicamba-tolerant soybeans for all preplant, at-planting, and pre-emergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For the proposed new use for post-emergence (in-crop) application of this product to dicamba-tolerant soybeans, the maximum single in-crop application rate is 16 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The maximum annual application rate for post-emergence in soybeans is 32 fluid ounces (1.0 lb a.e. dicamba) per acre.

The combined total per year for all applications must not exceed 64 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay is 14 days (R1 Growth stage).

Evaluation

In evaluating a pesticide registration application, the EPA assesses a wide variety of information on the pesticide's toxicity (*i.e.*, effects on humans and other non-target organisms), exposure (*i.e.*, where and how the pesticide is used), and environmental fate (*i.e.*, how the chemical will move in the environment) to determine the likelihood of adverse effects (*i.e.*, risk) to human health and the environment resulting from the proposed uses. Risk assessments are developed to evaluate the environmental fate of the compound as well as how it might affect a wide range of non-target organisms including humans, terrestrial and aquatic wildlife and plants. On the basis of these assessments, EPA evaluates and approves language for each pesticide label to ensure the directions for use and safety measures are appropriate to mitigate any potential risk. The pesticide's label helps to communicate essential limitations and mitigations that are necessary for public safety. Once the risks are assessed and mitigation measures have been incorporated, EPA balances any remaining potential risks against the benefits of the use of the product. EPA will grant an application if it determines that the benefits of the use of the product outweigh its risks.

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human health risk assessment for dicamba, risks were assessed in a manner that assures human health protection to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba in registered or proposed to be registered products that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data showing greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency seen with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the Agency assumes that any amount of

exposure will lead to some degree of risk. Thus, the Agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be “not likely” to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2) more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment of dicamba. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The Agency determined, based on a reviews of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, EPA assumes that any amount of exposure will lead to some degree of risk. Thus, EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainty factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and 1X for FQPA SF when applicable). The inhalation HEC/HED results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite also had a lack of findings in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) For dicamba, there is no

evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits.

After considering the available toxicity data, EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerances levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the Agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in

the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day. The significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models. Therefore, the Agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other substances. For the purposes of this Proposed Registration Decision, therefore, EPA has assumed that dicamba does not have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities.

Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the point of departure for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and proposed uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the Agency's LOC for both food and water. For the U.S. population the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food-form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being proposed for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to HED's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application inhalation exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the proposed uses of dicamba on dicamba-tolerant corn and soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. Volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40 acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Results of PERFUM modeling, however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates are not of concern.

4. Spray Drift

Spray drift is always a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The proposed maximum single application rate of dicamba is 1 lb ae/A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. For the purposes of the proposed uses on dicamba, this is considered a screening level assumption since the proposed use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate 1 lb ae/A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the FFDCA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- and long-term durations via the oral, dermal, and inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and proposed use sites. Drinking water values were incorporated directly into the assessment.

The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term aggregate risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short term aggregate risks.

6. Long-term aggregate risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the Agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

7. Occupational Risk Assessment

a. Short- and Intermediate-term handler Risk

EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on genetically -modified cotton and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short and Intermediate term Post-application Risk

EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard *via* the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation post application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The Agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The Agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the Agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the Agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on dicamba-tolerant soybean and cotton is provided below. More detailed discussions can be found in the Agency documents titled, *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708)* and *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701)*, and its addendums entitled, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean and Dicamba DGA*; *Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean*. These documents are in the docket. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water

and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would likely persist; however, EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for dicamba-tolerant soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. It may reach surface water via field/site runoff, spray drift during application, and by vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however EPA does not expect DCSA to reach groundwater at levels that would be of concern. The major route of exposure to non-target organisms is likely spray drift and runoff. Also, multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury. The assessments related to these routes of exposure are described in the sections below.

3. Runoff

The Agency has considered the potential effects due to runoff, and has developed proposed mitigation to limit off-site runoff. A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

The Agency considers spray drift exposure to be the principal risk issue associated with the proposed label use of dicamba DGA salt, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following dicamba applications, likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The Agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). EPA has also determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. Based on the weight of evidence approach, EPA determined that labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (*i.e.* NOAEC for soybean plant height).

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, the Agency had concerns regarding the volatility of dicamba, and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with a submission that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Though the Agency found the information helpful, the submission did not include enough detail to verify the measurements in the studies. Therefore, in order to be protective of potential effects to non-target plants from volatilization, labels must include language to maintain an in-field buffer (to the edge of the field in all directions) of 100 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate. Although the Agency is not requiring additional data to be submitted at this time, if EPA receives volatility data under varied conditions of temperature and relative humidity, as these factors play a strong role in volatility under field conditions, it may reconsider whether this mitigation requirement is necessary.

EPA is aware that for use of dicamba in Arkansas, the Arkansas Plant Board has an in-field buffer that is greater than what is being proposed by EPA (400 feet as opposed to 110 to 220 feet). EPA has reviewed the information associated with the larger buffer in Arkansas to assess why these differences exist. EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints, plant height, and yield, are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (*i.e.*, plant height) for the most sensitive plant species tested (*i.e.*, soybeans), EPA uses field studies and modeling to determine the distance from site of application to where the NOEC is not expected to be exceeded. It is further noted that the labels for the proposed uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are

drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer. In telephone conversations between EPA and the Arkansas Plant Board, it was reported that Arkansas' buffer distance of 400 feet was not computed as a result of submitted data, but as a precautionary measure that was based on information and observations from extension specialists from Arkansas and neighboring states, discussions with Monsanto, and historical information involving qualitative visual observations of damage in the field with products not containing the specific nozzle and pressure requirements contained on the proposed label. The Arkansas Plant Board felt that a 400 foot buffer should exceed what would be necessary to protect neighboring crop fields that are directly adjacent to fields receiving dicamba treatment. The Arkansas Plant Board also reports that their buffer requirement may be revisited and/or removed after a period of initial use (if registered) once additional observations are made.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic ($RQ = \text{Exposure} / \text{Toxicity}$). RQs are then compared to EPA's levels of concern (LOCs). The LOCs are criteria used by the Agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the Agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including cotton and soybean. The proposed uses on dicamba-tolerant soybeans and cotton would expand the timing of applications from pre-emergence and pre-harvest only for soybeans and pre-emergence and post-harvest only for cotton to allowing post-emergence over-the-top applications. The maximum yearly application rates would remain 2.0 lb a.e./acre for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./acre between pre-emergence and post-emergence applications.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad

default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded, EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations.

The results of the screening level risk assessments indicate that the RQs do not exceed the Agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the Agency's LOC. The screening level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both cotton and soybeans, based on the proposed maximum application rates, the screening level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the Agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, there is potential for ecological concerns related to a potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in dicamba-tolerant soybeans. Before considering mitigation measures, EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening level assessment, further refinement, as discussed below, suggest that risks are lower.

1. Risk to Birds

For birds, the screening level assessment indicated that the RQs exceeded the Agency's LOCs on an acute basis for both soybean and cotton. More specifically, the screening level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in dicamba-tolerant soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming soybean forage/hay.

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The Agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs.

Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns, suggesting that dicamba consumed in the diet may possibly be less available than assumed using dose-based exposures. Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger concerns for many food items. In addition, estimates of exposure in screening level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms with territories established at distance from the field. With this last line of evidence in mind, the draft pesticide label requires an in-field 110 to 220-foot buffer to further reduce off-site exposure for birds (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for birds feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

2. Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the Agency's LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening level assessment using the maximum exposure values from empirical datasets for DCSA residues in dicamba-tolerant soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. A screening level assessment using the maximum exposure values from empirical data for DCSA residues in dicamba-tolerant cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The Agency's screening level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in dicamba-tolerant soybeans and cotton plants to determine the RQ values. EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the draft pesticide label requires an on-field 110 to 220-foot buffer in all directions to further reduce off-site exposure for mammals (buffer is discussed in more detail in the "Risk to Plants" section, below). Exposures to DCSA residues are only expected for mammals feeding on dicamba-tolerant plants on the field, and are not expected off the field, regardless of spray drift of parent dicamba residues.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an Agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the proposed uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift, and for dicots in semi-aquatic areas due to runoff and spray drift. The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that labeling restrictions will help to reduce spray drift off field. The registrant submitted additional studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and the formulation in its application for registration. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1691 herbicide when an adequate buffer is incorporated between the application equipment and the edges of the treated field.

Additionally, to further mitigate against potential risks to plants from spray drift, the product labeling requires the use of 110-220 foot (depending on application rate) buffer between the last treated row and the closest edge of the field to be treated (in all directions). The Agency considered exposure to spray drift to be the principal risk issue associated with the proposed labeled use for all taxa. EPA considered a variety of lines of evidence, including past experience with other dicamba formulations and associated spray drift incident reporting.

4. Synergism

EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. In EPA's risk assessments, the Agency uses GLP guideline studies to determine potential toxicity to plants, involving apical endpoints such as biomass and reproductive health. EPA believes this approach is very reliable for these purposes. However, at this time, the topic of synergy and multiple stressors is an uncertainty in assessing risk to non-target plants including endangered

species. Therefore, EPA is proposing a tank mix prohibition on the M1691 label to address this uncertainty.

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this proposed decision.

In the screening level risk assessment performed for the new application timing of dicamba (DGA) on genetically modified cotton and soybean to be tolerant to dicamba, EPA determined that direct concerns were unlikely (*i.e.* levels of concern were not exceeded) for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degradate from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The Agency begins with a screening level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <https://www.epa.gov/endangered-species/ecological-risk-assessment-process-under-endangered-species-act>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening level assessment results in a determination that no levels of concern are exceeded EPA concludes its analysis. On the other hand, where the screening level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. EPA determines that there is “no effect” on listed species if, at any step in the screening level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening level assessment, a pesticide still

exceeds the Agency's levels of concern for listed species, EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening level assessment, takes account of species' habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening level ecological risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are Federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a no effect determination is identified for the corresponding taxon.

This registration for dicamba is being proposed for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an assessment of listed species is completed for any such state.

Based on EPA's LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), EPA identified the listed species that are inside the "action area" (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 30 states.

The following criteria were used to assess listed species in the action area:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have "no effect."
- For listed individuals outside the action area, use of a pesticide would be determined to have "no effect."
- Listed individuals inside the action area may either fall into the "no effect" or "may effect" categories depending upon their specific biological needs and circumstances of exposure.

- Those that fall under the “may effect” category are found to be either “likely” or “not likely to be adversely affected.” This determination is made in consultation with the Services
- A “likely” or “not likely to adversely affect” determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift mitigation language including a 360 degree infield buffer (to varying length, depending on application rate) on the label is intended to limit off site transport of dicamba DGA through spray drift, as well as volatilization. Therefore, EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, EPA concluded a no effect determination for all but 24 species originally identified as potentially at-risk (in the screening level assessment) because they are not expected to occur on cotton and soybean fields. The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in EPA’s refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, EPA made a determination that exposure occurring on the field would have “may affects” (either “unlikely to adversely affect” or “likely to adversely affect” on 2 species (the Spring Creek Bladderpod and the Audubon Crested Caracara) in 2 counties (Wilson county, TN and Palm Beach county, FL, respectively) within the States covered by this proposed decision. Furthermore, the Agency has concluded that the 2 species in question will not be of concern as the registrant has agreed to include on the final labeling a prohibition on application in both counties, thus mitigating any possible chance of exposure.

Additionally, the Agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, EPA’s analysis supports a “no effects” determination for runoff exposure for off-field listed plants for the proposed labeled use of dicamba DGA. Additionally, EPA is proposing to require rainfast mitigation on the label (“Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.”) to protect against the risk of exposure to listed species off the treated field.

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on genetically-modified crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, EPA is proposing, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a

lack of performance can communicate directly with Monsanto by a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the proposed uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label. The registrant must then evaluate the situation to determine if lack of performance is caused by resistance or likely resistance.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy^[i], et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers’ permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15th, 2018, on or before January 15th of each year, Monsanto must submit annual summary reports to EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, county and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The

annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the proposed dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The Agency received 11 comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2010-0496) for the application to register the use of dicamba on genetically-modified soybeans and no comments in response to the Notice of Receipt (Docket Number: EPA-HQ-OPP-2012-0841) for the application to register the use of dicamba on genetically-modified cotton. The majority of comments expressed concern (e.g., spray drift and volatilization) and requested that the Agency deny the proposed registration. The EPA welcomes input from the public during the decision process when registering pesticides, and is committed to thoroughly evaluating and mitigating any potential risks from registered pesticides, consistent with applicable statutory standards. EPA considered the public comments received in this regulatory decision.

The commenters focused on spray drift and volatilization concerns affecting non-target plants. The Agency has evaluated the risks regarding the potential drift of pesticides to sensitive crops and other non-target plants that may be adjacent to treatment areas. Specific label directions and restrictions have been proposed to protect from off-target movement of this pesticide product. Specifically, the proposed registration decision requires a 110-220 foot buffer between the treated area and edge of the field in all directions. These buffers are expected to keep spray drift from moving beyond the edge of the crop field to be treated as well as reduce the concern for volatility. In addition, the label will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide to distances within these buffers. The proposed regulatory decision also specifies that this product cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. Label language regarding spray volume, equipment ground speed, and spray boom height is intended to further protect against off-target drift. More details on EPA's and Monsanto's efforts to minimize effects to non-target plant species can be found in Section VIII.B.4 of this document.

Commenters also expressed concerns that weeds resistant to dicamba will become more prevalent as a result of this proposed use. Weed resistance is an increasing problem that has become a significant economic issue to growers. In an effort to address this concern and to prevent new weed resistance from happening, while giving growers another essential tool in their integrated pest management programs, Monsanto must put into place a stewardship program to promote responsible use of the proposed product in order to minimize the potential for increased

levels of weed resistance. This plan is discussed in detail in Section V and Section VIII.B.3 of this document.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Current registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the currently registered use of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba would expand weed management options on genetically-modified cotton and soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season would target new flushes of weeds, thereby reducing populations of these weeds and particularly would help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Proposed Registration Decision

In accordance with FIFRA, EPA only registers a pesticide when it can ensure that it will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, EPA is charged with balancing the uncertainties and risks posed by a pesticide against its benefits. EPA must determine if the benefits in light of its use outweigh the risks in order for the Agency to register a pesticide.

In the case for the proposed use of dicamba on dicamba-tolerant soybeans and cotton, and in consideration of all best available data and assessment methods, EPA believes this proposed decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. The Agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some levels of concern were exceeded for certain birds and mammals that may be in the fields that would be treated. The Agency notes that these are very conservative risk estimates using screening level (worst case) assumptions, and that they most likely do not apply to the majority of the birds and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated

field. Because of these additional restrictions, EPA expects the proposed uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the Agency's levels of concern.

On the benefits side of the analysis, use of dicamba on dicamba-tolerant soybeans and cotton is expected become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of U.S. soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states stretching across the southern half of the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on dicamba-tolerant soybeans and cotton would be beneficial as it provides an effective tool to treat especially noxious weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba could help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to soybean and cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the proposed labeling restrictions will include protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

After weighing all the risks of concern against the benefits of the proposed uses, EPA finds that when the proposed mitigation measures are applied, the risks that may remain are minimal, if they exist at all, while the benefits are potentially great. Therefore, the benefits outweigh the risks and registering these uses will not generally cause unreasonable adverse effects on human health or the environment during the 5-year time limited registration being proposed (a 5-year registration is proposed so that any unexpected weed resistance issues that may result from the proposed uses can be addressed before granting an extension or EPA can allow the registration to terminate if necessary). EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(5) registration finding for the proposed uses.

A. Data Requirements

There are no outstanding data requirements required to support the registration of this action. However, data may be required in connection with registration review activities for dicamba. Those requirements would be generic to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the proposed supplemental labels unless otherwise noted below.

- 1. Worker Protection** *(Although the following Worker Protection labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

- 2. Environmental Hazards** *(Although the following Environmental Hazards labeling applies to the proposed new uses, it is not included in the proposed supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the Agency on September 18, 2013 for this product.)*

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1691™ for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call XXXXXXXX.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless in conjunction with another mode of action herbicide with overlapping spectrum.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use the Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying M1691 Herbicide. Do not use any other nozzle and pressure combination not specifically allowed by this label.

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and are impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical

air mixing. The inversion will dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

a. Buffer

Maintain a 110-foot buffer (when applying 16 fl oz of this product per acre), or a 220-foot buffer (when applying 32 fl oz of this product per acre) between the treated area and the edge of the field in all directions.

b. Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1691 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1691 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.

- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 32 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 32 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans.
- The combined total application rate from crop emergence up to 7 days pre-harvest must not exceed 64 fluid ounce (2.0lb a.e dicamba) per acre for cotton.
- All applications for both cotton and soybeans must not exceed 64 fluid ounces (2.0 lb a.e dicamba) per acre.

C. Registration Terms

EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. EPA is basing the proposed registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

Monsanto must have an Herbicide Resistance Management (HRM) Plan for M1691 Herbicide developed and approved by EPA before a final registration can be issued. The HRM Plan must focus on educating growers on the appropriate use of the M1691 Herbicide and the associated dicamba-tolerant seeds. EPA is requiring that the HRM Plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

Monsanto or its representative must investigate reports of lack of herbicide efficacy as reported by users following “scouting.” When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for “likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Additionally, Monsanto must collect material, if possible, for further testing. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if

requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures.

c. Annual Reporting of Herbicide Resistance to EPA

Monsanto must submit annual summary reports to EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, county and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

2. EPA's Continued Control over the Registration

Because the issue of weed resistance is an extremely important issue to keep under control and can be very fast moving, this registration will expire 5 years from the date of the registration issuance, unless this term is removed or modified by EPA. At the end of 5 years, EPA can work to address any unexpected weed resistance issues that may result from the proposed uses before granting an extension or allow the registration to terminate if necessary.

3. Geographic Limitation on Use of Dicamba M1691 Herbicide

EPA is proposing to issue this registration only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62.
<http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>



Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean

Approved by: _____

A handwritten signature in black ink, appearing to read "J. E. Housenger", is written over a horizontal line.

Jack E. Housenger, Director
Office of Pesticide Programs

Date: _____

A handwritten date "11/9/16" is written in black ink over a horizontal line.

Summary

This document announces that the U.S. Environmental Protection Agency (the EPA or the agency) has granted a conditional registration under Section 3(c)(7)(B) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the new uses of the herbicide dicamba for use on genetically-engineered (GE) cotton and GE soybean that have been engineered to be resistant to dicamba in the following states: Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

These new dicamba uses were originally proposed by the Monsanto Company to be added to the currently registered herbicide product M1691 (the EPA Registration Number 524-582). This is the specific formulation that was listed in the agency's Proposed Decision released for public comment earlier this year. Since the proposed decision was published, the agency also assessed a lower volatility dicamba formulation (M1768, with the brand name Xtendimax™ with VaporGrip™ Technology, the EPA Registration Number 524-617). the EPA expects the lower volatility formulation to further reduce the potential off site movement of generic dicamba formulations and is included in today's regulatory decision.

The M1768 product contains the same active ingredient as M1691, diglycolamine (DGA) salt of dicamba, and is to be used with equivalent application rates and the same application techniques. Because the two products contain the same active ingredient used at the same rates with the same methods, all of the environmental and human health assessments completed and made public in connection with the proposed registration decision for the M1691 apply to M1768. After assessing volatility studies conducted on the M1768 formulation (discussed later in this document), the EPA has determined that the new lower volatility formulation of M1768 offers the user a product with less potential to volatilize and move off the target area. The volatility analysis is included in the docket for this final decision. Therefore, the new uses were granted for the M1768 formulation.

This final decision document discusses several agency considerations of the new uses for dicamba on GE soybean and GE cotton, including discussions of human health and environmental risks associated with the new uses as well as the benefits associated with these uses. the EPA considered all relevant data associated with the active ingredient when assessing its risks. For example, the assessment for human health included the N, N-Bis-(3-aminopropyl) methylamine (BAPMA) salt of dicamba (M1768 contains the DGA salt of dicamba) because the data on the BAPMA salt was relevant to the analysis and presented the most conservative risk estimation to be used in each exposure scenario to be protective of all exposures of dicamba. But, when product specific considerations were necessary for the analysis, the EPA reviewed the effects of the DGA salt. For example, to determine appropriate spray drift buffers, the agency examined drift potential using studies conducted on the DGA salt formulation.

Under the Plant Protection Act, the United States Department of Agriculture (USDA) deregulated the GE cotton and GE soybean seeds tolerant to dicamba on January 15, 2015.

I. Chemical Information

Chemical Name: Dicamba (benzoic acid, 3,6-dichloro-2-methoxy-, aka 3,6-dichloro-*o*-anisic acid)

EPA PC Code: 128931

Chemical Abstract Service (CAS) Number: 104040-79-1

Mode of Action: Dicamba is in the Benzoic Acid family that is used post-emergence for selective control of broadleaf weeds. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division.

Registrant: Monsanto Company

Product: M1768 Herbicide (Xtendimax™ with VaporGrip™ Technology) EPA Registration Number 524-617

Background

On April 28, 2010 and July 30, 2012, respectively, the EPA received applications from the Monsanto Company (Monsanto) to register new uses of dicamba, as the DGA salt, on GE soybean and GE cotton. The application also requested the establishment of new tolerances for residues resulting from the new uses. The tolerances for these new uses have been established.

Dicamba is an active ingredient that is currently used through acid formulations and a variety of salt formulations, and is registered for a variety of food and feed uses. The new uses will expand the current timing of dicamba applications to post-emergence (over-the-top) applications to GE cotton and GE soybean crops. Until this registration, dicamba was only registered for use on preplant and pre-harvest soybeans and on preplant and postharvest cotton. It is important to note that using registered dicamba products on GE cotton or GE soybean crops that are not registered specifically for post-emergence use on GE cotton or GE soybean crops is inconsistent with the pesticide's labeling and a violation of FIFRA.

New Uses

Cotton

Dicamba products that are currently registered on conventional cotton are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.25 to 1.0 pounds acid equivalent (lb a.e.) dicamba per acre. The maximum annual application for all preplant, at planting and pre-emergence applications combined on conventional cotton is 1.0 lb a.e. dicamba per acre per season.

For the new use, for post-emergence (in-crop) application of dicamba for use on GE cotton, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total of all in-crop applications for GE cotton is 88 fluid ounces (2.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, and pre-emergence treatments to GE cotton, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, and pre-emergence applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications (preplant, at-planting, pre-emergence and post-emergence (in-crop) must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. For example, if a preplant application of 44 fluid ounces (1.0 lb a.e. dicamba) per acre is made, then the combined total post-emergence (in-crop) annual applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for GE cotton.

The minimum retreatment interval is 7 days; the pre-harvest interval for cottonseed including the livestock feeding of cotton gin by-products is 7 days.

Soybeans

Dicamba products that are currently registered on conventional soybeans are used for preplant, at-planting and/or pre-emergent treatments at application rates that range from 0.125 to 0.5 pounds acid equivalent (lb a.e.) dicamba per acre and for preharvest burndown treatments at 0.25 to 1.0 lb a.e. dicamba per acre. The maximum annual application for all preplant, at planting, pre-emergence, and preharvest burndown applications combined on conventional soybeans is 1.0 lb a.e. dicamba per acre per season.

For the new use for post-emergence (in-crop) application of this product to GE soybeans, the maximum single in-crop application rate is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. This rate is also the minimum single application in order to reduce the selection for resistant weeds. The total for all in-crop applications for GE soybeans is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

For preplant, at-planting, pre-emergence, and preharvest burndown treatments to GE soybeans, applications must be made with a minimum application rate of 22 fluid ounces (0.5 lb a.e. dicamba) per acre. The total for all preplant, at-planting, pre-emergence, and preharvest applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.

The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. The minimum retreatment interval is 7 days; the pre-harvest interval, including feeding of soybean hay, is 14 days (R1 Growth stage).

II. Human Health Risk

A summary of the human health risk assessment, *Dicamba and Dicamba BAPMA Salt: Human-Health Risk Assessment for Proposed Section 3 New Uses on Dicamba-tolerant Cotton and Soybean*, is provided below.

As stated earlier in this document, the data associated with the BAPMA salt were considered to be the most appropriate form to use for assessing the potential for risks to human health. In the human

health risk assessment for dicamba, risks were assessed in a manner that protects human health from exposure to all forms of the chemical. This is a complex analysis because (1) there are a variety of different forms of dicamba that must be considered (e.g., dicamba acid, dicamba BAPMA salt, other dicamba salts such as DGA), (2) the data show greater toxicity for a major metabolite in foods (DCSA) relative to the parent compound, and (3) the different types of toxicity and potency with different routes of exposure (specifically, portal of entry effects observed in inhalation toxicity studies for BAPMA vs. other forms of dicamba).

When determining the safety of a pesticide, the EPA evaluates the available toxicity data and considers its validity, completeness, and reliability, as well as the relationship of the results of the studies to human risk. The EPA also considers available information concerning the variability of the sensitivities of major identifiable sub-groups of consumers, including infants and children. Once a pesticide's toxicological profile is determined, the EPA identifies toxicological points of departure (POD) and levels of concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the NOAEL) and the lowest dose at which adverse effects of concern are identified (the LOAEL). Uncertainty/safety factors are used in conjunction with the POD to calculate a safe exposure level - generally referred to as a population-adjusted dose (PAD) or a reference dose (RfD) - and a safe margin of exposure (MOE). For non-threshold risks (e.g., cancer), the agency assumes that any amount of exposure will lead to some degree of risk. Thus, the agency estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime (dicamba has been determined to be "not likely" to be carcinogenic and therefore a non-threshold approach does not apply in this case). For more information on the general principles the EPA uses in risk characterization and a complete description of the risk assessment process, see <http://www.epa.gov/pesticides/factsheets/riskassess.htm>.

The following risk assessment endpoints were selected for dicamba to be protective to all forms of the chemical.

- For the acute dietary assessment, the most sensitive, single-day toxic effect seen across the entire dicamba database was chosen for quantifying risks, i.e., maternal neurotoxic effects seen in a developmental toxicity study in which animals were dosed with the BAPMA salt. Although dietary exposure could occur from agricultural use of other salts of dicamba resulting in lower risk estimates, the assessment quantified risks assuming everyone exposed to dicamba would be exposed to the more toxic BAPMA salt to assure protection from all forms of the chemical.
- For the chronic dietary assessment, the endpoint was selected from a reproduction study in which animals were dosed with the DCSA metabolite (a plant metabolite), a compound much more chronically toxic than any of the parent dicamba acid or salts pesticides. Although chronic dietary exposure could occur from exposure to various salts of dicamba rather than just this metabolite, risks were estimated assuming all residues in foods were the more toxic metabolite, thus assuring protection from all forms of the chemical.
- For the inhalation exposure assessment, risks were quantified separately for the BAPMA salt vs. other forms of dicamba since the BAPMA salt is (1) only used in agricultural settings and residential inhalation exposures would therefore not be expected, and (2)

- more toxic than other forms of dicamba with regard to portal of entry inhalation toxicity.
- Finally, we assessed the toxicity specific to the counter-ion of the BAPMA salt, i.e., BAPMA itself. Since the BAPMA salt shows increased toxicity via inhalation, the BAPMA was included in the aggregate risk assessment. The potential for increased risk resulting from this chemical was assessed and determined to be low relative to the toxicity from the parent compounds and DCSA; therefore, protecting for exposures to the parent compounds and DCSA will also protect for exposures to BAPMA itself.

A. Summary of Toxicological Effects

The toxicology database for dicamba is complete and sufficient for assessing the toxicity and characterizing the hazard of dicamba. Toxicology studies for dicamba acid, its salts [isopropylamine (IPA), diglycolamine (DGA), and N, N-Bis-(3-aminopropyl) methylamine (BAPMA)], and the plant metabolites [DCSA (3, 6-dichlorosalicylic acid) and DCGA (3, 6-dichlorogentisic acid)] were all considered for risk assessment for these new uses. In scenarios where co-exposure to the various forms could occur, the most protective point of departure (POD) was utilized.

Dicamba acid has been classified as having a low acute toxicity via oral, dermal and inhalation routes (Acute Toxicity Categories III or IV). It is both an eye and dermal irritant (Toxicity Category II), but it is not a skin sensitizer.

Dicamba is classified as “not likely to be carcinogenic to humans” based upon the lack of evidence of carcinogenicity in mice and rats in the acid form when tested at adequate dose levels. The agency determined, based on review of epidemiological data (see Elizabeth Evans and Shanna Recore, *Dicamba: Tier I (Scoping) Review of Human Incidents and Epidemiology*, 11/10/15), that the existing data did not support a conclusion that links human cancer to dicamba exposure.

B. Toxicological Endpoints and Doses Used in the Human Health Risk Assessment

Once a pesticide’s toxicological profile is determined, the EPA identifies toxicological Points of Departure (POD) and Levels of Concern (LOC) to use in evaluating the risk posed by human exposure to the pesticide. For hazards that have a threshold below which there is no appreciable risk, the toxicological POD is used as the basis for derivation of reference values for risk assessment. PODs are developed based on a careful analysis of the doses in each toxicological study to determine the dose at which no adverse effects are observed (the No Observed Adverse Effect Level (NOAEL)) and the lowest dose at which adverse effects of concern are identified (the Lowest Observed Adverse Effect Level (LOAEL)). Uncertainty factors (UF)/safety factors (SF) are used in conjunction with the POD to calculate a safe exposure level – generally referred to as a Population-adjusted Dose (PAD) or a Reference Dose (RfD) – and a safe Margin of Exposure (MOE). For non-threshold risks, the EPA assumes that any amount of exposure will lead to some degree of risk. Thus, the EPA estimates risk in terms of the probability of an occurrence of the adverse effect expected in a lifetime.

1. Acute Dietary

The acute dietary endpoint was selected from the dicamba BAPMA salt rat developmental toxicity

study, which represents the most sensitive endpoint in the dicamba toxicology database resulting from a single-dose dietary exposure. The NOAEL is 29 mg/kg/day, and the LOAEL is 86 mg/kg/day based on ataxia, unsteady gait, and convulsions in female rats. This NOAEL POD is protective of acute effects of dicamba via the oral route of exposure to the general population, including infants and children. A separate acute dietary endpoint for reproductive females ages 13-49 is not required since no acute developmental toxicity effects were observed in the dicamba database. An uncertainly factor of 100X was applied with 10X for interspecies extrapolation from animal to human, and 10X for intraspecies variation in sensitivity amongst the human population. As discussed in Section C below, the Food Quality and Protection Act (FQPA) safety factor was reduced to 1X, resulting in an aRfD/aPAD of 0.29 mg/kg/day.

2. Chronic Dietary

The chronic dietary endpoint was selected from the DCSA plant metabolite reproduction toxicity study, which represents the most sensitive endpoint in the toxicology database resulting from repeated-dose dietary exposure. The NOAEL is 4 mg/kg/day, and the LOAEL is 37 mg/kg/day based on decreased pup weights. The NOAEL POD is protective of chronic effects of dicamba via the oral route of exposure to the general population, including infants and children. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a cRfD/cPAD of 0.04 mg/kg/day.

3. Incidental Oral (Short- and Intermediate-Term)

The incidental oral endpoint was selected from the dicamba acid rat multi-generation reproductive toxicity study, which represents the most appropriate endpoint in the toxicology database for assessing short- (1 to 30 days) and intermediate-term (1 to 6 months) incidental oral (hand-to-mouth) exposure. The NOAEL is 136 mg/kg/day, with a LOAEL of 450 mg/kg/day based on impaired pup growth. A 100X UF was applied (10X interspecies and 10X intraspecies), and as discussed in Section C below, the FQPA SF was reduced to 1X resulting in a level of concern of 100.

4. Inhalation (All Durations)

For dicamba acid and the DGA salt inhalation risk assessment for short and intermediate term durations, the POD was based on the route-specific dicamba acid inhalation toxicity study in Wistar rats with a LOAEL of 0.050 mg/L based on local effects of hyperplasia in the lungs and lymph nodes (NOAEL = 0.005 mg/L, non-systemic, pulmonary regional deposited dose ratio (RDDR) = 0.590).

The standard interspecies extrapolation UF can be reduced from 10X to 3X for dicamba acid due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic (not pharmacodynamic) interspecies differences. Therefore, the LOC for dicamba acid inhalation exposures is for MOEs less than 30 (3X for interspecies extrapolation, 10X for intraspecies variation, and as discussed in Section C below, 1X for FQPA SF when applicable). The inhalation HEC results are listed in Appendix A.5.

5. Dermal (All Durations)

No dermal endpoint was selected since no adverse effects were observed in the subchronic dermal studies for dicamba acid, IPA salt, and DGA salt up to the limit dose.

6. Cancer

Dicamba is classified as “Not Likely to be Carcinogenic to Humans.” This decision was based on the lack of findings in the cancer studies in rats and mice, which were tested at adequate dose levels to assess the carcinogenicity of dicamba. Mutagenicity studies generally did not demonstrate evidence of mutagenic potential for dicamba and the concern for genotoxicity in the acid form is low. Epidemiology studies were also examined, and no links were found to dicamba exposure and cancer. Additionally, the DCSA metabolite lacked findings of carcinogenicity in a chronic/carcinogenicity study in rats.

C. FQPA Safety Factor

The EPA has determined that the 10X FQPA Safety Factor for protection of infants and children, mentioned above, can be reduced to 1X for the acute and chronic dietary risk assessment for the following reasons and discussed in more detail below: (1) The toxicity database for dicamba is complete with respect to the required 870 guideline studies. (2) There is no evidence of increased susceptibility following *in utero* exposures to rats and rabbits and following pre and/or post-natal exposure to rats in a two-generation reproduction study. For the dicamba acid and BAPMA salt, no developmental toxicity was seen at the highest doses tested in the prenatal developmental studies with rats. (3) Consistent neurotoxic signs (e.g., ataxia, decreased motor activity, impaired righting reflex and gait) were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the EPA determined that there is no need for a developmental neurotoxicity study or additional UFs to account for neurotoxicity due to the following: (i) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (ii) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (iii) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological findings were seen in two sub-chronic neurotoxicity studies at the limit dose or other chronic studies.

There are no residual uncertainties identified in the exposure databases. The acute dietary food exposure assessment was performed using tolerance level residues and 100% crop treated assumptions. The chronic dietary food exposure assessment used average residues for crops, tolerance levels for livestock commodities, and percent crop treated assumptions for several registered uses. Conservative ground and surface water estimates calculated using the latest models were used. Similarly, conservative residential Standard Operating Procedure (SOPs) were used to assess post-application exposure of children as well as incidental oral exposure of toddlers. These assessments will not underestimate the exposure and risks posed by dicamba.

1. Completeness of the Toxicology Database

The toxicity database for dicamba is adequate to characterize the potential for prenatal or postnatal risk to infants and children. Acceptable rat and rabbit developmental toxicity studies, two rat 2-generation reproduction studies, and acute/subchronic neurotoxicity studies in rats are available.

2. Evidence of Neurotoxicity

There is evidence of neurotoxicity resulting from exposure to dicamba throughout the toxicology database (i.e., impaired gait, impaired righting reflex, ataxia, decreased motor activity, rigidity upon handling, etc). These signs of neurotoxicity were observed in multiple studies in rats and rabbits. However, after considering the available toxicity data, the agency determined that a developmental neurotoxicity study (DNT) is not required for the following reasons: (1) although clinical signs of neurotoxicity were seen in pregnant animals, no evidence of developmental anomalies of the fetal nervous system were observed in the prenatal developmental toxicity studies, in either rats or rabbits, at maternally toxic doses up to 300 or 400 mg/kg/day, respectively; (2) there was no evidence of behavioral or neurological effects on the offspring in the two-generation reproduction study in rats; (3) the ventricular dilation of the brain in the combined chronic toxicity and carcinogenicity study in rats was only observed in females at the high dose after two years of exposure at doses of 127 mg/kg/day, but the significance of this observation is questionable, since no similar histopathological finding was seen in two sub-chronic neurotoxicity study at the limit dose or other chronic studies.

3. Evidence of Sensitivity/Susceptibility in the Developing or Young Animal

There is no evidence of susceptibility to the young following *in utero* exposure to dicamba acid, dicamba BAPMA or DCSA. Quantitative offspring susceptibility was observed in the 2-generation reproduction study for the DCSA metabolite based on decreased pup weights, which occurred at a dose at which no parental effects were observed. However, the degree of concern for the susceptibility is low, because there is a well-established NOAEL for offspring toxicity in that study and DCSA has rapid clearance. Additionally, the current points of departure are health protective and therefore address the concern for offspring toxicity observed in the reproduction studies.

4. Residual Uncertainty in the Exposure Database

The residential exposure assessment assumes maximum label use rate as well as other conservative assumptions. The acute dietary exposure assessment is based on an exaggerated exposure scenario which assumes that all commodities being consumed retain tolerance level residues, and the chronic dietary exposure assessment assumes field trial residues in which the crops were treated using the use patterns likely to lead to maximum residues. Additionally, the drinking water estimates utilized conservative models (e.g., models using screening level assumptions). Therefore, the agency does not believe that exposure to dicamba will be underestimated.

D. Cumulative effects

The EPA has not made a common mechanism of toxicity finding for dicamba and any other substance, and dicamba does not appear to produce a toxic metabolite produced by other

substances. Therefore, the EPA finds for this decision that dicamba does not have a common mechanism of toxicity with other substances. For information regarding the EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by the EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on the EPA's website at <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/cumulative-assessment-risk-pesticides>.

E. Dietary (Food + Drinking Water) Risk

Dicamba is a selective systemic herbicide used to control a variety of broadleaf weeds and registered for a variety of food/feed uses. Permanent tolerances for dicamba are established under 40 CFR § 180.227 for a wide variety of crops and livestock commodities. Acute and chronic aggregate dietary food and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 3.16. This software uses 2003-2008 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

1. Acute Dietary Risk

For acute exposure assessments, individual one-day food consumption data are used on an individual-by-individual basis. The reported consumption amounts of each food item are multiplied by a residue point estimate and summed to obtain a total daily pesticide exposure for a deterministic exposure assessment, or "matched" in multiple random pairings with residue values and then summed in a probabilistic assessment. The resulting distribution of exposures is expressed as a percentage of the aPAD on both a user basis (i.e., only those who reported eating relevant commodities/food forms) and a per-capita basis (i.e., those who reported eating the relevant commodities as well as those who did not). In accordance with the EPA policy, per capita exposure and risk are reported for analyses.

Risks are considered to be of no concern when they are less than 100% of the aPAD or cPAD, a value determined by dividing the POD for the most sensitive and pertinent toxicological effect for each exposure scenario by required uncertainty factors. The acute analysis was an unrefined determination which used tolerance level residues and assumed 100 percent crop treated (%CT) for all existing and new uses. The dietary exposure analyses that were performed result in acute dietary risk estimates that are below the agency's LOC for both food and water. For the U.S. population, the exposure was 0.042760 mg/kg/day, which utilized 15% of the acute population adjusted dose (aPAD) at the 95th percentile. The highest exposure and risk estimates were for all infants (<1 year old). At the 95th percentile, the exposure for all infants (<1 year old) was 0.089 mg/kg/day, which utilized 31% of the aPAD.

2. Chronic Dietary Risk

For chronic dietary exposure assessment, an estimate of the residue level in each food or food form (e.g., orange or orange juice) on the food commodity residue list is multiplied by the average daily consumption estimate for that food/food form to produce a residue intake estimate. The resulting

residue intake estimate for each food/food form is summed with the residue intake estimates for all other food/food forms on the commodity residue list to arrive at the total average estimated exposure. Exposure is expressed in mg/kg body weight/day and as a percent of the cPAD. This procedure is performed for each population subgroup.

The chronic analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant % crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

F. Residential (Non-Occupational) Exposure/Risk Characterization

There are no residential uses being established for dicamba with this current registration; however, there are existing residential uses of dicamba that have been reassessed in this document to reflect updates to the agency's 2012 Residential SOPs along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for dicamba. Registered uses of dicamba include solid and liquid products in concentrates or ready-to-use sprays for use as spot and broadcast treatments on turf.

1. Residential Handler Exposure

Based on the currently registered uses, residential handlers may receive exposure to dicamba when mixing, loading and applying the pesticide to lawns and turf. Since there was no dermal hazard identified for dicamba, only inhalation risk estimates were quantitatively assessed. The inhalation risk estimates were based on the following application scenarios:

- Mix/Load/Apply Liquid with Hand-held Equipment
- Apply Ready-To-Use Sprays with Hand-held Equipment
- Load/Apply Granules with Hand-held Equipment

The MOEs for the exposure scenarios assessed range from 190 to 220,000. Since there is potential risk concern only when inhalation MOEs are less than a LOC of 30, residential handler exposures are not a concern.

2. Post-application Exposure

There is the potential for post-application exposure for individuals exposed as a result of being in an environment that has been previously treated with dicamba. Since no dermal hazard was identified for dicamba, the quantitative exposure/risk assessment for residential post-application exposures is based on the following scenarios:

- Children (1 to < 2 years old) incidental oral exposure to treated turf.
- Children (1 to < 2 years old) episodic granular ingestion exposure.

Since dicamba products registered for use on residential turf come in both liquid and granular

formulations, both are accounted for in this assessment. The assessment of post-application exposure to liquid formulations is protective of exposure to solid formulations, except for the episodic granular ingestion scenario which was quantitatively assessed. The life stages selected for assessment are health protective for the exposures and risk estimates for any other potentially exposed life stages.

The post-application assessment for turf includes only the incidental oral routes of exposure. The series of assumptions and exposure factors that served as the basis for completing the residential post-application risk assessment are detailed in the 2012 Residential SOPs (<https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide>). In addition, chemical-specific residue data were used in the assessment. The residential post-application risk estimates are not of concern for dicamba since all MOEs are greater than the LOC of 100 (the lowest MOE = 6600 for use of liquids on lawns).

3. Residential Bystander Post-application Inhalation Exposure

The potential exposure to bystanders from vapor phase dicamba residues emitted from treated fields has been evaluated for the new uses of dicamba on GE corn and GE soybean. Bystander exposure to dicamba emitted from treated fields depends on two main factors: 1) the rate at which these chemicals volatilize from a treated field (described as the off-gassing, emission or flux), and 2) how those vapors are dispersed in the air over and around the treated field. In general, volatilization can occur during the application process or thereafter. It can result from aerosols evaporating during application, while deposited sprays are still drying (possibly via co-distillation), or after as dried deposited residues volatilize.

Volatilization modeling for a single day was completed using the Probabilistic Exposure and Risk model for Fumigants (PERFUM). There are a variety of factors that potentially affect the emission rates of dicamba and subsequent offsite transport including: field condition (bare soil, growing or mature crop canopy), field parameters (soil type, moisture, etc.), formulation type, meteorological conditions, and application scenario (rate, method).

A chemical-specific flux study was used to estimate a flux rate of 0.0004 ug/m²/s for dicamba. This flux rate, along with an assumption of a single 40-acre field, and using Bradenton, FL meteorological data from Bradenton, FL were used with PERFUM to estimate risk.

The field volatility study suggests that volatilization of dicamba from treated crops does occur, which could result in bystander exposure. Although a more recent volatility study conducted using the M1768 formulation was submitted and reviewed, which demonstrated comparable potential for volatility as described in greater detail in the document entitled *Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton* available in the docket for this action, that study was not available at the time this Human Health assessment was developed. Results of PERFUM modeling using the Bradenton, FL study however, indicate that airborne concentrations are negligible, and even at the edge of the treated fields risk estimates for potential human bystander exposure are not of concern.

4. Spray Drift

Without considering mitigation measures, it is reasonable to assume that spray drift may be a potential source of exposure to residents nearby to spraying operations. Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues are calculated using drift modeling coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessments is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them. Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis, analogous to how exposures to turf products are considered in risk assessment.

Several dicamba products have existing labels for use on turf, thus it was considered whether the risk assessment for that use would be considered protective of any type of exposure that would be associated with spray drift. Because the registered residential uses on turf result in exposure greater than potential exposure from spray drift, no new residential assessment needs to be completed. If the maximum application rate on crops adjusted by the amount of drift expected is less than or equal to existing turf application rates, the existing turf assessment is considered protective of spray drift exposure. The maximum single application rate of dicamba for this new use is 1 lb a.e./A. The highest degree of spray drift noted for any application method immediately adjacent to a treated field (Tier 1 output from the aerial application using fine to medium spray quality) results in a deposition fraction of 0.26 of the application rate. This spray drift fraction estimation differs from that used for environmental exposures because, unlike environmental risk assessment that uses estimations to determine exposures at the edge of the treated field, estimations for human health risk assessment are used to assess the average deposition over a wide area of lawn. For the purposes of the new uses on dicamba, this is considered a screening level assumption since the new use is for groundboom applications only. A quantitative spray drift assessment for dicamba is not required because the maximum application rate to a crop/target site multiplied by the adjustment factor for drift of 0.26 is less than the maximum direct spray residential turf application rate of 1 lb a.e./A for any dicamba products. The turf post-application MOEs have been previously assessed, are based on the revised SOPs for Residential Exposure Assessment, and were not found to be of concern, as noted above.

5. Aggregate Risk Assessment

In accordance with the Federal Food, Drug, and Cosmetic Act (FFDCA), the EPA must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard, or the risks themselves can be

aggregated. When aggregating exposures and risks from various sources, the EPA considers both the route and duration of exposure. Since residential exposure is expected, aggregate exposure consists of exposure from residential, food and drinking water sources.

Acute and chronic aggregate risks include only dietary exposure from food and drinking water sources. Since there are residential uses, short-term aggregate risks were assessed which include contributions from food, drinking water, and residential exposure. Intermediate-term aggregate risks were not considered as residential exposure is not expected to occur for more than 30 days. Cancer aggregate risk was not quantified since dicamba is not a carcinogen. A common toxicological endpoint of concern was not identified for short-, intermediate- or long-term durations via the oral, dermal, or inhalation routes. Therefore, the aggregate exposure risk assessment should include exposure across the oral routes only, as appropriate for the populations of concern (i.e., food and water for adults; and food, water and incidental oral for children).

a. Acute Aggregate Risk

The acute aggregate risk assessment includes only food and water exposure; therefore, the acute dietary (food and drinking water) assessment represents acute aggregate risk. The acute dietary exposure assessment was conducted using tolerance-level residues, DEEM default processing factors and 100% crop-treated information for all registered and new use sites. Drinking water values were incorporated directly into the assessment. The most highly exposed population subgroup is all infants (<1 year old; 31% of the aPAD). The acute dietary exposure estimates are not of concern for the general U.S. population or any population subgroup.

b. Short-term Aggregate Risk

The short-term aggregate risk assessment includes food, water and residential exposure. The resulting short-term aggregate risks are not of concern for children (MOEs > LOC 100). For adults, since there was no dermal hazard identified in the route-specific dermal studies and the inhalation effects were not systemic, the chronic dietary assessment is protective for short-term aggregate risks.

c. Long-term Aggregate Risk

The chronic (long-term) aggregate risk assessment includes only food and water exposure. The chronic dietary analysis was a partially refined determination which used average residues based on field trial studies for crops, tolerance levels for livestock commodities, and relevant percent crop treated (CT) data for several existing uses. The chronic risk estimates for dicamba are below the agency's LOC for the general U.S. population and all population subgroups. The highest exposure and risk estimates were for the population subgroup of children ages 1-2 with a risk estimate for dicamba for food and water of 42% of the cPAD.

6. Occupational Risk Assessment

a. Short- and Intermediate-term Handler Risk

The EPA uses the term occupational handler to describe people who mix, load and/or apply pesticides professionally (e.g., farmers, professional pesticide applicators). Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used (e.g., mixing/loading liquids for ground boom application, and applying sprays by ground boom equipment), occupational handler exposure is expected from the new uses.

The occupational handler risk estimates are not of concern (i.e., MOEs > LOC of 30) for all of the scenarios for the use of dicamba on GE cotton and GE soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOEs are 380 for mixer/loaders and 250 for applicators using ground boom equipment.

b. Short- and Intermediate-term Post-application Risk

The EPA uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as reentry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

i. Dermal Post-application Risk

There is no potential hazard via the dermal route for dicamba; therefore, a quantitative occupational post-application dermal risk assessment was not completed.

ii. Inhalation Post Application Risk

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (<http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037>). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (<https://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2014-0219-0002>). During Registration Review, the agency will utilize this analysis to determine if additional data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for the active ingredient dicamba, generically.

In addition, the agency is continuing to evaluate the available post-application inhalation exposure data generated by the Agricultural Reentry Task Force. Given these two efforts, the agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

III. Environmental Risk

A summary of the environmental fate and ecological effects, and potential environmental risks from the use of dicamba on GE soybean and GE cotton is provided below. More detailed discussions can be found in the agency documents titled:

- *Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON87708) and*
- *Ecological Risk Assessment for Dicamba DGA Salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed Post-Emergence New Use on Dicamba-Tolerant Cotton (MON 87701), and its addendums entitled,*
- *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of Dicamba on Dicamba-Tolerant Soybean and*
- *Dicamba DGA; Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean and*
- *M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide, EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton.*

These documents are in docket number EPA-HQ-OPP-2016-0187, available at regulation.gov. A fuller description of how these potential risks are assessed can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>.

A. Environmental Fate

1. Degradation

Dicamba is generally stable to abiotic processes, and is more persistent under anaerobic conditions. It is stable to abiotic hydrolysis at all pH levels and photodegrades slowly in water and soil. Under anaerobic soil conditions, the dicamba parent molecule has a half-life of 141 days. It is not persistent under aerobic conditions; aerobic soil metabolism is the main degradative process for dicamba, with a half-life of 6 days. Dicamba was found in two acceptable field dissipation studies in soil segments deeper than 10 cm with half-lives ranging from 4.4 to 19.8 days. In aquatic systems, dicamba degrades more rapidly when sediment is present and has an aerobic soil metabolism half-life in sediment-water system of ~24 days.

The major degradate of dicamba is 3,6-dichlorosalicylic acid (DCSA). It is persistent when formed under anaerobic conditions, comprising more than 60% of the applied dose after 365 days of anaerobic incubation in sediment-pond water system. DCSA is not persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent dicamba with a half-life of 8.2 days. Like the parent molecule, DCSA is mobile and was also found in the two acceptable field studies in soil segments deeper than 10 cm. If it were to reach anaerobic groundwater, it would

likely persist; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent dose. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent molecule and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil-water system during anaerobic aquatic degradation of dicamba under laboratory conditions. DCSA was also a major metabolite in plant metabolism and magnitude of residue studies for GE soybean and cotton, comprising approximately 80% and 20%, respectively, of dicamba-related residues in plant tissues for these crops.

2. Mobility

Dicamba is very soluble and mobile. Without considering mitigation measures on the product label, possible pathways for reaching surface water include field/site runoff, spray drift during application, and vapor drift from volatilization. It is not expected to bioaccumulate in aquatic organisms as it is an anion at environmental pHs. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to reach groundwater. The major degradate of dicamba, DCSA, is persistent under anaerobic conditions; however, the EPA does not expect DCSA to reach groundwater at levels that would be of concern. Without considering mitigation measures, the major route of exposure to non-target organisms is likely spray drift and runoff. While multiple literature studies show that there is potential for high vapor drift for certain dicamba salts and formulations from soybean fields resulting in non-target plant injury, the available dicamba M1768 formulation volatility research the agency has reviewed indicates that non-target plant biomass and yield will not be affected by use of the M1768 formulation. The assessments, which can be found in the docket for this action, related to these routes of exposure are described in the sections below.

3. Runoff

The agency considered the potential effects due to runoff and developed mitigation to limit off-site runoff that is reflected in the approved labeling for these new uses (e.g., Do not make application of this product if rain is expected in the next 24 hours.). A component of the model used to assess terrestrial risk assumes that the mass of pesticide running off the treated field is directly related to the pesticide's solubility in water. In the case of dicamba DGA salt, the dissociated salt yields highly soluble dicamba acid. The model assumes that the high solubility of the acid results in a runoff mass of 5 percent of the field-applied mass, which is considered to be a highly conservative estimate because the model does not account for loss of chemical from degradation, partitioning, or the temporal aspects of runoff (e.g., a rain event following application that exceeds soil's field capacity).

4. Spray Drift

Without consideration of mitigation measures on the approved label, the agency considers spray drift exposure to be the principal risk issue to be considered with these new uses, owing to a variety of lines of evidence, including past experience with other dicamba formulations. In addition, visual observations of off-field plant damage have been reported following applications of currently registered dicamba products (not containing the same labeling restrictions), likely the result of subsequent spray drift and/or volatilization of dicamba residues.

The agency used a weight of evidence approach incorporating spray drift modeling, a spray drift droplet deposition study, and raw data from field trials to determine an appropriate in-field buffer to avoid dicamba exposure to non-target organisms (e.g., endangered plants). The EPA determined that the label must specify that nozzles must be used that produce extra-course and ultra-course droplet spectra for application to reduce the potential for spray drift. The approved labeling for this action contains these restrictions. Based on the weight of evidence approach, the EPA also determined that labels must include language to maintain an in-field buffer (downwind at the time of application) of 110 feet when applying at the 0.5 lb a.e./A application rate and 220 feet when applying at the 1.0 lb a.e./A application rate in order to restrict the movement of residues to the field. Using these buffers, expected residues at the field's edge from spray drift would be below apical endpoints for the most sensitive tested species (i.e., NOAEC for soybean plant height). The approved labeling for this action includes these restrictions.

5. Volatilization

After reviewing submitted data relating to the volatility of dicamba, and at the time the EPA proposed these new uses, the agency had concerns regarding the volatility of dicamba and possible post-application, vapor-phase off-site transport that might damage non-target plants. Monsanto responded to these concerns with an additional submission post-proposal that acknowledged the long-recognized volatility of dicamba acid and described measurements of the volatilization in the different formulations.

Based on field volatility (flux) studies (conducted in accordance with the label conditions such as nozzle and ground speed limitations) and laboratory vapor-phase toxicity and exposure (humidome) studies, the 110-foot omnidirectional buffer for volatilization is no longer warranted for the dicamba DGA plus VaporGrip™ (M1768) formulation, because the expected exposure at field's edge is less than the NOAEC for plant risk.

The EPA's buffer is determined by evaluation of plant toxicity data required under FIFRA and conducted under GLP conditions where apical endpoints (plant height and yield) are used as measures of plant growth and reproduction. Once the no observed adverse effect concentration (NOAEC) was determined for the most sensitive endpoint (i.e., plant height) for the most sensitive plant species tested (i.e., soybeans), the EPA uses field studies and modeling to determine the distance from site of application to where the NOAEC is not expected to be exceeded. It is further noted that the labels for the new uses will specify a spray nozzle and pressure combination that is expected to reduce drift of the herbicide, which are drift reduction measures not on the previously registered dicamba formulations and could also influence the size of a protective buffer.

B. Ecological Risk

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The process of integrating the results of exposure with the ecotoxicity data is called the risk quotient method. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values, both acute and

chronic ($RQ = \text{Exposure}/\text{Toxicity}$). RQs are then compared to the EPA's levels of concern (LOCs). The LOCs are criteria used by the agency to indicate potential risk to non-target organisms. The criteria indicate whether a pesticide, when used as directed, has the potential to cause adverse effects to non-target organisms.

For terrestrial animals, the agency's acute risk LOCs are set at 0.5 for non-listed species and 0.1 for listed species. For aquatic animals, acute risk LOCs are also set at 0.5 for non-listed species but for listed species, they are set at 0.05. The chronic risk LOC is set at 1.0 for both terrestrial and aquatic animals. For plants, acute risk LOCs are set at 1 for both non-listed and listed species. The potential difference in sensitivity for listed plant species compared to non-listed plant species is addressed through the use of different toxicity endpoints in the RQ equation [the concentration causing effects to 25% of the test population (EC25) for non-listed plants vs the NOAEC or concentration causing effects to 5% of the test population (EC05) for listed species]. Chronic risk is not assessed for plants.

Dicamba is currently registered for use on several food and non-food use sites, including conventional cotton and soybean. The new uses on GE soybeans and GE cotton expand the timing of applications from only pre-emergence and pre-harvest for soybeans and only pre-emergence and post-harvest for cotton to allowing post-emergence over-the-top applications on these GE crops. The maximum yearly application rates would remain 2.0 lb a.e./A for both cotton and soybeans. However, as detailed in section I of this document, the applicator could now split the 2.0 lb a.e./A between pre-emergence and post-emergence applications.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on seeds that have been genetically modified to be tolerant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment based on its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at <http://www.epa.gov/oppfead1/endanger/litstatus/riskasses.htm>]. That assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. If the screening - level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental concentrations at the species-specific level.

The results of the screening-level risk assessments indicate that the RQs do not exceed the agency's LOC for terrestrial invertebrates (including pollinators), freshwater fish, aquatic-phase amphibians, estuarine/marine fish, freshwater invertebrates, or estuarine/marine invertebrates for either acute or chronic exposures. Acute RQs for aquatic plants and mammals, and chronic RQs for birds, reptiles, and terrestrial-phase amphibians also do not exceed the agency's LOC. The screening-level assessment uses broad default assumptions to establish estimated environmental concentrations of particular pesticides. It does not make effects determinations related to any particular listed species. Instead, species-specific assessments are conducted for effects determinations. A more detailed description can be found in Section IV below.

For both GE cotton and GE soybeans, based on the new maximum application rates, the screening-

level analysis indicates that risks for acute exposure to listed and non-listed birds, and listed and non-listed terrestrial dicot plant species, result in RQs that exceed the agency's LOCs. For soybeans, there is also a potential for direct adverse effects to birds and mammals from chronic exposure to the dicamba degradate DCSA. Though the rates are similar to those in currently registered dicamba pesticide products, the potential for ecological concerns is related to the potential increase in acres treated with dicamba products, resulting in additional acres with residues of DCSA in GE soybeans. Before considering mitigation measures, the EPA also found a potential for increased susceptibility of direct adverse effects to late season plants from spray drift.

While concern levels are exceeded in the screening-level assessment, further refinement, as discussed below, suggest that risks are lower and confined to the treated field under the mitigations imposed on the registration. Risks above the level of concern remain for terrestrial plants and animals on the treated field; comparison of the risk to benefits associated with the new use are described in Section VIII.

1. Risk to Birds

For birds, the screening-level assessment (which assumed that 100% of diet is from the treated field) indicated that the RQs exceeded the agency's LOCs on an acute basis for both GE soybean and GE cotton. More specifically, the screening-level assessment found that the acute LOCs are exceeded for listed and non-listed birds, with a maximum acute dose-based RQ of 2.21 for small birds consuming short grass. Chronic LOCs were also exceeded for birds feeding on DCSA residues in GE soybeans, with a maximum chronic dietary RQ of 1.7 for small birds consuming GE soybean forage/hay.

The agency's screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba DGA residues on food items consumed by birds. These residue estimates have been developed for a variety of wildlife food items, and are based on measured residues from a large number of field trials on many pesticides. The agency's assessment also used the maximum labeled rate of the pesticide and the empirical maximum measured concentrations for DCSA residues in GE soybeans and cotton plants to determine the RQ values. To represent a maximum, or "worst-case" estimate of risk, these high-end exposure estimates for a variety of food items were compared, across a variety of body weights and sizes, to the most sensitive oral dose toxicity endpoint in order to generate RQs. Some of these RQs exceeded the LOC. While the LOCs were exceeded, further consideration of all lines of evidence shows that risks under more realistic use scenarios are expected to be lower. For example, high-end dicamba residues compared to endpoints from toxicity studies using chemicals incorporated in the animal's diet do not trigger concerns. This suggests that dicamba consumed in the diet may be less available than assumed using dose-based exposures. Expected field exposure is more likely to be accounted for by the dietary studies that did not indicate risk exceeding levels of concern rather than the acute oral dose studies where risk exceeding thresholds of concern was indicated. As mentioned above, the screening-level analysis assumes that 100% of the diet comes from the treated field which may overestimate total dicamba ingestion.

Further, more frequently expected residues levels, such as mean or median estimates of exposure, would be lower by a factor of two or more, suggesting that residues are often not likely to trigger

concerns for many food items. In addition, estimates of exposure in screening-level assessments are the maximum levels expected, and represent residues at the actual point of application, right on the field. The exposure analysis in this screening-level risk assessment indicates that the transport of dicamba off-field by spray drift decreases with distance, suggesting that exposures to dicamba, and therefore associated risks, can be substantially lower for organisms that are off the treated field. With this last line of evidence in mind, the pesticide label requires an in-field 110 to 220-foot downwind buffer to eliminate off-site exposure above threshold levels that would trigger risk concern for birds (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for birds feeding on GE plants on the field, and are not expected off the field (since DCSA formation is only a result of dicamba tolerant-plant metabolism).

2.Risk to Mammals

For parent dicamba, none of the RQs for mammals exceed any of the agency’s LOCs. Acute RQs range from <0.01 to 0.04 and chronic RQs range from 0.01 to 0.84. However, the screening-level assessment using the maximum exposure values from empirical datasets for DCSA residues in GE soybean resulted in exceedances of the chronic LOC for all size classes of mammals consuming soybean forage and hay, or consuming insects that had consumed soybean tissues with DCSA residues. These RQs range from 1.1 to 3.3. The screening-level assessment using the maximum exposure values from empirical data for DCSA residues in GE cotton did not result in exceedances of the chronic LOC for any mammal (chronic RQs ranged from <0.01 to 0.34).

The agency’s screening-level assessment employed residue estimates based on reasonable upper bound modeling assumptions for dicamba residues, the maximum labeled rate of the pesticide, and the empirical maximum measured concentrations for DCSA residues in GE soybeans and GE cotton plants to determine the RQ values. The EPA further considered more realistic residue estimates and other lines of evidence, such as food preferences and foraging ranges relative to distance from the site of application. This analysis showed reduced concerns for adverse effects because larger mammals have more varied diets and larger home ranges where feeding is more likely to occur well away from treatment areas. As described in the section for risk to birds, the screening-level assessment assumes that 100% of the diet comes from the treated field.

Consideration of these lines of evidence also produces reduced risk estimates for small herbivorous mammals, due to reduced exposure, but does not reduce risk estimates for these organisms to the point that concern levels are not exceeded. As in the case for birds, the pesticide label requires an in-field 110 to 220-foot downwind buffer eliminate off-site exposure above threshold levels that would trigger risk concern for mammals (buffer is discussed in more detail in the “Risk to Plants” section, below). Exposures to DCSA residues are only expected for mammals feeding on GE plants on the field, and are not expected off the field.

3. Risk to Plants

For aquatic plants, the only RQ that would exceed an agency LOC of 1.0 is for any listed non-vascular aquatic plants for the parent dicamba, with an RQ of 8.5. However, there are currently no listed non-vascular aquatic plants.

Dicamba exposure to terrestrial and semi-aquatic plants was estimated through modeling for plants residing near a use area that may be exposed via runoff and/or spray drift. Only a single application at the maximum rate for a particular use and compound-specific solubility information is considered, because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure, and that subsequent exposures do not contribute to the response. Hence, estimates are based on application rate, the solubility factor, and default assumptions of drift.

For a single application of dicamba at the maximum label rate for the new uses, the RQs exceeded the LOC (1.0) for terrestrial dicots due to spray drift (without mitigation measures), and for dicots in semi-aquatic areas due to runoff and spray drift (without mitigation measures). The RQs for dicots in semi-aquatic areas were 4.15 for non-listed species and 7.58 for listed species. The RQs for spray drift were 19.49 for non-listed species of dicots and 38.31 for listed species of dicots. The RQs for dicots in dry areas were 0.49 for non-listed species and 0.89 for listed species which are both less than the LOC for plants of 1.0.

Although the RQ analysis indicated there may be risks to plants from runoff and spray drift, studies conducted on the dicamba DGA formulation demonstrates that the approved labeling restrictions will keep the product on the field, thereby reducing spray drift off field. These determinations were made after reviewing additional registrant submitted studies for a refined spray drift analysis using the specific Tee Jet® TT11004 nozzles and a change in the formulation to be registered. The analysis indicates that the dicamba product applied through the specific Tee Jet® TT11004 nozzle is protective of plants from exposures of the M1768 Herbicide when an in-field 110 to 220-foot downwind buffer is incorporated between the application equipment and the edges of the treated field. Therefore, potential risks to plants from spray drift is mitigated by requiring a 110-220 foot (depending on application rate) buffer downwind at the time of application.

4. Synergism

The agency views synergism to be a rare event and intends to follow the National Research Council's recommendation for government agencies to proceed with estimating effects of pesticide mixtures with the assumption that the components have additive effects¹ in the absence of any data to support the hypothesis of a synergistic interaction between pesticide active ingredients. However, data is being cited in connection with patent claims submitted to the U.S. Patent and Trademark Office (USPTO) for claims of synergism for specific combinations of dicamba with other herbicides.

The EPA is aware that a common agricultural practice involves tank mixing of pesticides, resulting in the co-occurrence of chemical stressors to non-target plants including endangered species. This phenomenon has been described in academic research as well as patent application filings with the USPTO where the combined mixture is sometimes claimed to have enhanced activity or synergistic effects. The endpoints in these patent application studies were based on visual observations of weed control and injury, and so were not directly applicable to the EPA's quantitative risk assessment process for plants, in which measures of sub-lethal effects (plant height and weight) serve as sensitive effects thresholds for risk estimation purposes. The EPA believes this quantitative

¹ The phrase 'additive effects' is used when the effect of the combination of chemicals can be estimated directly from the sum of the scaled exposure levels (dose addition) or of the responses (response addition) of the individual components.

approach is very reliable for the purpose of potential toxicity to plants.

The agency is continuing its work with that information in order to better understand the scope of these uncertainties for these specific combinations and to develop an approach that best manages the potential risks while still maintaining the important benefits derived from tank mixing. While evaluation of these data are still in progress, the agency is requiring that the end-use product label allow only tank mixing with other herbicides in combinations that have not been granted patents for synergistic behavior at the time of this registration. For prohibited combinations, if the EPA determines that sufficient data do not exist to support synergistic effects with a particular active ingredient, or if the agency has evaluated data that is more directly applicable to the agency's quantitative risk assessment process for plants that demonstrates that no increased toxicity to plants exists and are therefore not of concern, that ingredient may then be allowed in tank mix combinations. A list of acceptable tank mixes will be maintained by Monsanto on their already established website, www.xtendimaxapplicationrequirements.com

IV. Endangered Species for Dicamba Diglycolamine Salt (DGA)

Below is a summary of the endangered species assessments for dicamba (DGA). More detailed discussions can be found in the EPA documents titled, *Addendum to Dicamba Diglycolamine Salt (DGA) Section 3 Risk Assessment: Refined Endangered Species Assessment for Proposed New Uses on Herbicide-Tolerant Soybean and Cotton in 16 states (Arkansas, Illinois, Iowa, Indiana, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin)*; *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soybean in 7 U.S. States: AL, GA, KY, MI, NC, SC, and TX*; and *Addendum to Dicamba Diglycolamine (DGA) Salt Section 3 Risk Assessment: Endangered Species Effects Determinations for Dicamba DGA on Herbicide-Tolerant Cotton and Soy in 11 U.S. States: AZ, CO, DE, FL, MD, NM, NJ, NY, PA, VA and WV*. These documents are in the docket for this final decision.

In the screening-level risk assessment performed for the new application timing of dicamba (DGA) on GE cotton and GE soybean to be resistant to dicamba, the EPA determined that levels of concern were not exceeded for mammals (acute) and (chronic- for cotton use only), birds, reptiles, and terrestrial-phase amphibians (chronic from parent dicamba or DCSA degrade from use on cotton), terrestrial insects, freshwater fish, aquatic-phase amphibians (acute and chronic), estuarine/marine fish (acute and chronic), freshwater invertebrates (acute and chronic), estuarine/marine invertebrates (acute and chronic), and aquatic plants (vascular and non-vascular). However, potential indirect effect risk concerns were identified for any species that have dependencies (e.g., food, shelter, and habitat) on mammals, birds, reptiles, terrestrial-phase amphibians, or terrestrial plants that are directly affected.

The EPA has a specific process based on sound science that it follows when assessing risks to listed species for pesticides like dicamba that will be used on GE seeds to be resistant to the pesticide. The agency begins with a screening-level assessment that includes a basic ecological risk assessment consistent with its 2004 Overview of the Ecological Risk Assessment Process document. [USEPA, 2004, available at [species/ecological-risk-assessment-process-under-endangered-species-act](http://www.epa.gov/species/ecological-risk-assessment-process-under-endangered-species-act)]. That assessment uses broad default assumptions to establish estimated

environmental concentrations of particular pesticides. If the screening-level assessment results in a determination that no levels of concern are exceeded, the EPA concludes its analysis. On the other hand, where the screening-level assessment does not rule out potential effects (exceedances of the level of concern) based on the broad default assumptions, the EPA then uses increasingly specific methods and exposure models to refine its estimated environmental exposures. At each step, the EPA compares the more refined exposures to the toxicity of the pesticide active ingredient to determine whether the pesticide exceeds levels of concern established for listed aquatic and terrestrial species. The EPA determines that there is “no effect” on listed species if, at any step in the screening-level assessment, no levels of concern are exceeded. If, after performing all of the steps in the screening-level assessment, a pesticide still exceeds the agency’s levels of concern for listed species, the EPA then conducts a species-specific refined assessment to make effects determinations for individual listed species. The refined assessment, unlike the screening-level assessment, takes account of species’ habitats and behaviors to determine whether any listed species may be affected by use of the pesticide.

The screening-level risk assessment generates a series of taxonomic (e.g., mammals, birds, fish, etc.) risk quotients (RQs) that are the ratio of estimated exposures to acute and chronic effects endpoints. These RQs are then compared to the EPA established levels of concern (LOCs) to determine if risks to any taxonomic group are of concern. The LOCs address risks for both acute and chronic effects. Acute effects LOCs range from 0.05 for aquatic animals that are federally-listed threatened or endangered species (listed species) to 0.5 for aquatic non-listed animal species and 0.1 to 0.5 for terrestrial animals for listed and non-listed species. The LOC for chronic effects for all animal taxa (listed and non-listed) is 1. Plant risks are handled in a similar manner, but with different toxicity thresholds (NOAEC/EC₀₅ and EC₂₅, respectively) used in RQ calculation for listed and non-listed species and an LOC of 1 used to interpret the RQ. As described above, if the screening-level assessment shows that an RQ exceeds either the acute or chronic LOC, a concern for direct toxic effects is identified for that particular taxon and a species-specific assessment is necessary to make an effects determination. On the other hand, if RQs fall below the LOC, a No Effect determination is identified for the corresponding taxon.

This registration for dicamba has been finalized for registration for use in the states of Alabama, Arkansas, Arizona, Colorado, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Mexico, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. Additional states may be added to the labeling once an acceptable assessment of listed species is completed for any such state.

Based on the EPA’s LOCATES v.2.4.0 database and information from the U.S. Fish and Wildlife Service (USFWS), the EPA identified the listed species that are inside the “action area” (area of concern where use of pesticide may result in exposure to endangered species) associated with the new cotton and soybean uses within a total of 34 states.

The following criteria are used to make a species-specific effects determination:

- For listed individuals inside the action area but not part of an affected taxa nor relying on the affected taxa for services involving food, shelter, biological mediated resources necessary for survival and reproduction, use of a pesticide would be determined to have NO EFFECT.
- For listed individuals outside the action area, use of a pesticide would be determined to have NO EFFECT.
- Listed individuals inside the action area may either fall into the NO EFFECT or MAY EFFECT categories depending upon their specific biological needs and circumstances of exposure.
- Those that fall under the MAY EFFECT category are found to be either LIKELY or NOT LIKELY TO ADVERSELY AFFECT the listed species.
A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial
- A NOT LIKELY TO ADVERSELY AFFECT determination is made using criteria that categorizes the effect as insignificant, highly uncertain, or wholly beneficial.

Spray drift label mitigation language including an in-field spray drift buffer of 110 feet (for the 0.5 lb/A rate) and 220 feet (for the 1.0 lb/A rate) downwind at the time of application is expected to limit off site transport of dicamba DGA through spray drift. Therefore, the EPA expects that exposure will remain confined to the dicamba (DGA) treated field. Consequently, the EPA concluded a NO EFFECT determination for all but 24 species originally identified as potentially at-risk (in the screening-level assessment) because they are not expected to occur on cotton and soybean fields.

The 24 remaining listed species that were not ruled out because their range contains areas that include treated fields were considered in more depth in the EPA's refined endangered species assessments. Species-specific biological information along with dicamba (DGA) use patterns were also considered. After utilizing processes such as refined modeling incorporating species-specific information and migration habits, the EPA made a determination that exposure occurring on the field would have "may affects" (either "unlikely to adversely affect" or "likely to adversely affect" on 3 species (the Eskimo Curlew, the Spring Creek Bladderpod in Wilson county, TN, and the Audubon Crested Caracara in Palm Beach county, FL) within the States covered by this final decision. The EPA initiated informal consultation with the U.S. Fish and Wildlife Service (FWS) for the Eskimo curlew. The FWS concurred with the "unlikely to adversely affect" determination and no further action need be taken relative to this species. Furthermore, to address the remaining effects, the registrant submitted revised labeling and the EPA approved the labeling that prohibits application in both Wilson county, TN and Palm Beach county, FL. Therefore, the EPA makes no effect determinations for all listed species that are expected to be on the treated fields.

Additionally, the agency considered the potential effects attributed to runoff. As refined modeling predictions indicate that expected exposures from runoff (sheet flow) are below the most sensitive toxicological endpoint thresholds, the EPA's analysis also supports a no effects determination for runoff exposure for off-field listed plants for the new labeled use of dicamba DGA. To further protect species off the treated field against runoff, rainfast mitigation is required on the label ("Do not irrigate treated fields for at least 24 hours after application of this product. Do not make application of this product if rain is expected in the next 24 hours.").

V. Resistance Management

The emergence of herbicide resistant weeds is an increasing problem that has become a significant issue to growers. This has led to a concern that the use of dicamba on GE crops may result in over-reliance on dicamba and result in a larger number of resistant weeds. Currently, in certain areas of the United States there are populations of Kochia and prickly lettuce known to be resistant to dicamba. Kochia infests millions of acres of soybean and cotton and, in addition, glyphosate-resistant biotypes have been identified in Kansas and Nebraska.

In an effort to address these issues, the EPA is requiring, as a term of registration, that Monsanto develop an Herbicide Resistance Management (HRM) plan that will promote herbicide resistance management efforts by growers, the registrant, and others. The plan mandates that Monsanto must investigate any reports of lack of performance. Dicamba users who experience a lack of performance can obtain direct support from Monsanto through a toll free telephone number that is identified on the label to get advice on how to resolve any uncontrolled weeds.

“Lack of performance” refers to inadequate weed control with various possible causes, including, but not limited to: application rate, stage of weed growth, environmental conditions, herbicide resistance, plugged nozzle, boom shut off, tank dilution, post-application weed flush, unexpected rainfall event, weed misidentification, etc. It can be challenging to distinguish emerging weed resistance from other causes at an early stage. Therefore, the EPA has identified criteria that should be used to evaluate instances of “lack of performance” to determine if they do in fact constitute “likely herbicide resistance.” These “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species (Norsworthy, et al., 2012). The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present. The responsibilities of the registrant if “likely herbicide resistance” is found are discussed below.

Researchers, extension specialists, growers, USDA, and other leaders involved with pest management all acknowledge the importance of scouting (e.g., monitoring the fields) in herbicide resistance management. For the new uses, the labeling states that fields should be scouted before application of dicamba to identify the weed species present as well as their stage of growth. Fields also should be scouted after each application to identify lack of performance that may be the early signs of resistance. Additionally, the labeling states that in the event that a user encounters lack of performance they should report this to Monsanto or its representative using the toll-free number identified on the label.

When a lack of performance is identified and reported to the registrant, Monsanto or its representative must investigate and conduct a site visit if needed to evaluate the lack of performance using decision criteria identified by leading weed science experts in order to determine if “likely herbicide resistance” is present (also termed “possible resistance” by Norsworthy et al., 2012). A report of lack of herbicide performance to Monsanto will be the trigger to start this investigation.

When Monsanto or its representative applies the Norsworthy, et al., criteria cited above, and likely herbicide resistance is identified, Monsanto must proactively engage with the grower to control and

contain likely resistant weeds in the infested area. This may be accomplished by re-treating with an herbicide or using mechanical control methods. After implementing these measures, Monsanto must follow-up with the growers, with the growers' permission, to determine if the likely resistant weeds have been controlled. Monsanto must also annually report to the EPA findings of likely herbicide resistance. In addition, prior to implementing control measures, Monsanto must make best efforts to obtain samples of the likely herbicide resistant weeds and/or seeds, and as soon as practicable, laboratory or greenhouse testing must be initiated in order to confirm whether resistance is the reason for the lack of herbicide efficacy.

Beginning January 15, 2018, on or before January 15th of each year thereafter, Monsanto must submit annual summary reports to the EPA. These reports must include a summary of the number of instances of likely and confirmed resistance by weed species, crop, and state. These reports will also summarize the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years.

Monsanto must report annually any inability to control likely resistant weeds to relevant stakeholders. To accomplish this, Monsanto must establish a website to facilitate delivery of resistance information to users.

Several best management practices that are designed to help users avoid initial occurrences of weed resistance appear on the final dicamba product label listed under the Herbicide Resistance Management heading of the label. These practices are discussed in Section VIII.B.3 of this document.

Refer to Section VIII.C below for the EPA's terms of registration to address the issue of weed resistance.

VI. Response to Comments

The agency received 21,710 comments in response to the public participation process (Docket ID: the EPA-HQ-OPP-2016-0187) regarding the EPA's proposed decision for the application to register the use of dicamba on GE cotton and GE soybeans. Comments received were both in favor of and opposed to the decision to register the new uses which will provide growers with additional tools to control broadleaf weeds. The EPA welcomes input from the public during the decision process when registering significant new uses, and is committed to reviewing the comments received and determining whether changes or further mitigation are necessary to meet the applicable statutory standards. The EPA reviewed and evaluated the comments received during the comment period before issuing this final regulatory decision. Since many of the comments covered similar concerns, the comments were grouped into major topic areas. Please see *Response to Public Comments Received Regarding the New Use of Dicamba on Dicamba-Tolerant Cotton and Soybeans* dated November 7, 2016 for the agency's response to these comments.

VII. Benefits

Growers throughout the United States have experienced yield and economic losses due to weeds developing resistance to the herbicide glyphosate and other heavily used herbicides. The need for additional tools to manage these resistant weeds has become important as resistance to both glyphosate and other herbicides has become a significant financial, production and pest

management issue for many cotton and soybean growers. Weeds such as marehail, giant ragweed, common waterhemp, and Palmer amaranth can be difficult to control during the crop growing season. Previously registered uses of dicamba only allow for pre-plant application and post-harvest application in cotton for conventional or conservation tillage systems. Similarly, the previously registered uses of dicamba on soybeans only allows for preplant application along with a pre-harvest broadcast or spot treatment application. New postemergence uses of dicamba will expand weed management options on GE cotton and GE soybeans by providing an additional mechanism of action during the growing season. Dicamba used during the season will target new flushes of weeds, thereby reducing populations of these weeds and particularly will help reduce seed banks. Postemergence use of dicamba will expand options for weed control in cotton and soybeans and enable control of broadleaf weeds, including glyphosate-resistant biotypes.

VIII. Registration Decision

In accordance with FIFRA, the EPA only registers a pesticide when it finds that the use will not cause unreasonable adverse effects on man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide. Under FIFRA, the EPA is charged with balancing the uncertainties and risks posed by a pesticide against the benefits associated with the use of the pesticide. The EPA must determine if the benefits in light of its use outweigh the risks in order for the agency to register a pesticide.

In the case for the new uses of dicamba on GE soybeans and GE cotton, and in consideration of all best available data and assessment methods, the EPA determines that its decision to register these uses meets the requirements of FIFRA. The database submitted to support the assessment of human health risk is sufficient for a full hazard evaluation and is considered complete and adequate to evaluate risks to infants and children. The agency has not identified any risks of concern in regards to human health, including all population subgroups, or for occupational handlers.

In terms of ecological risk, some LOCs were exceeded for certain birds, reptiles, amphibians, and mammals that may be in the treated fields. These assessments included conservative risk estimates using screening-level (worst case) assumptions that are unlikely to apply to the majority of the birds, reptiles, amphibians, and mammals that are outside of the treatment area. For example, it is assumed that animals would forage for food exclusively in the treated area consuming only the treated crop, neither of which is likely to be true. Additionally, the protections afforded by the labeling, such as the requirement of infield buffers, would reduce the likelihood of spray drift and volatilization that could affect organisms located beyond the treated field. Because of these additional restrictions, the EPA expects these uses to have less environmental impact than other currently registered products that do not require the same buffers. It is also noted that, if further refinements that included more realistic exposure scenarios were conducted, these risks would likely fall below the agency's levels of concern.

On the benefits side of the analysis, use of dicamba on GE soybeans and GE cotton is expected to become an important part of a resistance management strategy for these crops. Soybeans and cotton are extremely important agricultural commodities in the United States and the world. According to the USDA's National Agricultural Statistics Service, soybeans are grown on approximately 85 million acres and cotton is grown on approximately 9 million acres. USDA's Economic Research Service describes soybeans as the world's largest source of animal protein feed

and the second largest source of vegetable oil, and describes cotton as one of the most important textile fibers in the world, accounting for around 35 percent of total world fiber use. The United States is the world's leading soybean producer and exporter, and together with China and India provide two-thirds of the world's cotton. USDA estimates the gross value of soybean production at approximately 48 billion dollars in the United States, and soybean is grown throughout the United States with more than 80 percent of the United States soybean acreage concentrated in the upper Midwest. The gross cotton production is estimated by USDA at over 6 billion dollars in the United States, and is grown in 17 states in the United States. However, resistance to glyphosate, the current market leader in soybeans and cotton, is having severe economic consequences in soybean and cotton production. The Weed Science Society of America and other weed control experts warn that the problem of glyphosate resistance is increasing, and that significant economic consequences will continue to increase without effective alternatives for weed control.

Consequently, use of dicamba on GE soybeans and GE cotton is beneficial as it provides an effective tool to treat especially noxious weeds, such as marehail, giant ragweed, common waterhemp, and Palmer amaranth, including glyphosate-resistant biotypes that threaten soybean and cotton production today. By adding an effective tool to combat glyphosate-resistant weeds, dicamba can help reduce this difficult weed pressure and aid significantly in production, reducing economic losses to GE soybean and GE cotton growers. In addition, effective treatment of glyphosate-resistant weeds can help control the spread of resistance. And, as stated previously, using dicamba for these uses according to the approved labeling restrictions will include further beneficial protections such as in-field buffers, best practice requirements for drift management and application techniques, and active resistance management stewardship of weed populations.

The EPA finds these benefits important. Furthermore, this regulatory decision includes a number of requirements that are expected to effectively limit concerns for off field risk. This registration action is only for a product confirmed by data to be a lower volatility formulation. In addition, the label requires very specific and rigorous drift mitigation measures, including in-field buffers, aerial application prohibitions, boom height requirements, specific nozzle and spray pressure requirements, and wind and tractor speed limitations. These mitigations are known to profoundly impact any drift potential from pesticide application. In aggregate, these formulations and labeling requirements are expected to eliminate any offsite exposures and effectively prevent risk potential to people and non-target species.

After weighing all the risks of concern against the benefits of the new uses, the EPA finds that when the mitigation measures for these uses are applied, the benefits of the use of the pesticide outweighs any remaining minimal risks, if they exist at all. Therefore, registering these new uses will not generally cause unreasonable adverse effects on human health or the environment. the EPA believes that the available data and scientific assessments as well as the overall considerations for benefits for weed management in these important crops support a FIFRA Section 3(c)(7)(B) registration finding for the new uses. Although the EPA proposed registering dicamba under FIFRA section 3(c)(5), new data requirements have been identified through registration review that will be applicable to all dicamba products (and all uses), therefore the agency is registering these new uses under FIFRA section 3(c)(7)(B).

A. Data Requirements

Although there are currently no outstanding data require to support the final registration of this action, the EPA has identified data that will be required in connection with Registration Review activities for dicamba. Those requirements will be applicable to dicamba uses and products in general and would be handled in accordance with the registration review process.

B. Labeling Requirements

The following labeling is included in the final supplemental labels unless otherwise noted below.

1. Worker Protection

(Although the following Worker Protection labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on May 1, 2014 for this product.)

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 24 hours.

PPE required for mixers, loaders, applicators and other handlers is:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls worn over short sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

2. Environmental Hazards

(Although the following Environmental Hazards labeling applies to the new uses, it is not included in the new supplemental labeling. This labeling can be found in the previously accepted master labeling that was accepted by the agency on September 18, 2013 for this product.)

Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

3. Resistance Management

To aid in the prevention of developing weeds resistant to this product, the following steps should be followed:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Apply full rates of M1768 Herbicide for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Report any incidence of non-performance of this product against a particular weed species to your Monsanto retailer, representative or call 1-844-RRXTEND.
- If resistance is suspected, treat weed escapes with an herbicide having a mode of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production.

Additionally, users should follow as many of the following herbicide resistance management practices as practicable:

- Use a broad spectrum soil-applied herbicide with other modes of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative modes of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Avoid using more than two applications of dicamba and any other Group 4 herbicides within a single growing season,
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

4. Spray Drift Management

Nozzle type:

Use only Tee Jet® TTI11004 nozzle with a maximum operating pressure of 63 psi when applying XtendiMax™ With VaporGrip™ Technology or any other approved nozzle found at www.xtendimaxapplicationrequirements.com. Do not use any other nozzle and pressure combination not specifically listed on this website. www.xtendimaxapplicationrequirements.com

Spray Volume:

Apply this product in a minimum of 10 gallons of spray solution per acre. Use a higher spray volume when treating dense vegetation.

Equipment Ground Speed:

Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but do not exceed a ground speed of 15 miles per hour. Slower speeds generally result in better spray coverage and deposition on the target area.

Spray boom Height:

Spray at the appropriate boom height based on nozzle selection and nozzle spacing, but do not exceed a boom height of 24 inches above target pest or crop canopy. Set boom to lowest effective height over the target pest or crop canopy based on equipment manufacturer's directions. Automated boom height controllers are recommended with large booms to better maintain optimum nozzle to canopy height.

Temperature and Humidity:

When making applications in low relative humidity or temperatures above 91 degrees Fahrenheit, set up equipment to produce larger droplets to compensate for evaporation. Larger droplets have a lower surface to volume ratio and can be impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions:

Do not apply this product during a temperature inversion. Off-target movement potential can be high during a temperature inversion. During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on evenings and nights with limited cloud cover and light to no wind. Cooling of air at the earth's surface takes place and warmer air is trapped above it. They can begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing. The inversion will often dissipate with increased winds (above 3 MPH) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

Wind Speed:

Drift potential is lowest between wind speeds of 3 to 10 miles per hour. Do not apply at wind speeds greater than 15 mph. A chart is included in the product label that lists the appropriate wind speeds and application conditions and restrictions.

5. Protection of Sensitive Areas:

Buffer

Maintain a 110 foot downwind buffer (when applying 22 fluid ounces of this product per acre) or a 220 foot downwind buffer (when applying 44 fluid ounces of this product per acre) between the last treated row and the closest downwind edge (in the direction in which the wind is blowing). If any of the following areas below are directly adjacent to the treated field, the areas listed below can be considered part of the buffer distance.

To maintain this required buffer zone:

- No application swath can be initiated in, or into an area that is within the applicable buffer distance.

The following areas may be included in the buffer distance calculation when adjacent to field edges:

- Roads, paved or gravel surfaces.
- Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, sorghum, proso millet, small grains and sugarcane. If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant and not conventional cotton and/or soybeans.
- Agricultural fields that have been prepared for planting.
- Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

Susceptible Plants:

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or the crops thereof rendered unfit for sale, use or consumption. Do not allow contact of herbicide with foliage, green stems, exposed non-woody roots of crops, and desirable plants, including beans, cotton, flowers, fruit trees, grapes, ornamentals, peas, potato, soybean, sunflower, tobacco, tomato, and other broadleaf plants, because severe injury or destruction may result, including plants in a greenhouse. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants.

Applicators are required to ensure that they are aware of the proximity to sensitive areas, and to avoid potential adverse effects from off-target movement of M1768 Herbicide. Before making an application, the applicator must survey the application site for neighboring sensitive areas prior to application. The applicator should also consult sensitive crop registries for locating sensitive areas where available.

Failure to follow the requirements in this label could result in severe injury or destruction to desirable sensitive broadleaf crops and trees when contacting their roots, stems or foliage.

Specifically, commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are sensitive to dicamba. In order to prevent unintended damage from any drift of this product, do not apply this product when the wind is blowing towards adjacent commercially grown sensitive crops.

6. Application Restrictions:

- Do not apply this product aerially.
- Do not tank mix any other herbicides with M1768 Herbicide.
- Do not make an application of the product if rain is expected in the next 24 hours.
- The maximum combined quantity of this product that may be applied for all preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season for both cotton and soybeans.
- The maximum application rate for a single, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for both cotton and soybeans.
- The combined total application rate from crop emergence up to R1 must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre for soybeans per year.
- The combined total application rate from crop emergence up to 7 days' pre-harvest must not exceed 88 fluid ounce (2.0lb a.e dicamba) per acre for cotton per year.
- All applications for both cotton and soybeans must not exceed 88 fluid ounces (2.0 lb a.e dicamba) per acre per year.

C. Registration Terms

The EPA has determined that certain registration terms are needed to ensure that likely weed resistance as discussed in section V will be adequately addressed. The EPA believes that it is important to address likely weed resistance and not wait until confirmation that resistance has been found. The EPA is basing the final registration terms on a list of criteria, presented in the peer-reviewed publication, Norsworthy, et al., "Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations," *Weed Science* 2012 Special Issue: 31–62 (Norsworthy criteria).

1. Herbicide Resistance Management (HRM) Plan

The EPA is issuing this registration with a term that requires Monsanto to have an Herbicide Resistance Management (HRM) Plan for M1768 Herbicide. The HRM Plan will focus on educating growers on the appropriate use of the M1768 Herbicide and the associated dicamba-tolerant seeds. The EPA is requiring that the HRM plan include the following measures that will reduce the potential for the development of weed resistance.

a. Investigation

The EPA is requiring that Monsanto or its representative investigate reports of lack of herbicide efficacy as reported by users following "scouting." When investigating any reports of lack of herbicide efficacy, Monsanto or its representative must make an effort to evaluate the field for

“likely resistance” by applying the “Norsworthy criteria.”

b. Remediation

If “likely resistance” is found, Monsanto must engage with the grower to control and prevent the spread of likely resistant weeds in the affected area. Monsanto must provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other nonchemical controls, as appropriate, and if requested by the grower, Monsanto will assist the grower in implementing those additional weed control measures. Additionally, Monsanto must routinely collect plant material for further testing.

c. Annual Reporting of Herbicide Resistance to the EPA

Monsanto must submit annual summary reports to the EPA that include a summary of the number of instances of likely and confirmed weed resistance by weed species, crop, and state. The annual reports must include summaries of the status of laboratory or greenhouse testing for resistance. The annual reports will also address the disposition of incidents of likely or confirmed resistance reported in previous years. These reports will not replace or supplement adverse effects reporting required under FIFRA § 6(a)(2).

d. Reporting of Likely Resistance to other Interested Parties

Monsanto must inform growers and other stakeholders of cases of likely resistance that are not resolved by the application of additional weed control measures.

e. Education

Monsanto must develop an education program that will provide growers with the best available information on herbicide resistance management.

D. Registration Expiration

The issue of weed resistance is an extremely important issue to keep under control and can be very fast moving. Also, the EPA is aware of reports of off-site incidents potentially due to the illegal use of dicamba products that do not employ the lower volatility formulation of dicamba DGA plus VaporGrip™ (M-1768) on GE cotton and GE soybean. Although the EPA finds that herbicide resistance is adequately addressed by the required herbicide resistance plan and does not expect off-site incidents to occur due to the specific measures required (described above) to this registration, the agency is requiring expiration dates that will ensure that the EPA retains the ability to easily modify the registration or allow the registration to terminate if necessary.

Specifically, this registration automatically expires on November 9, 2018, unless the EPA determines before that date that off-site incidents are not occurring at unacceptable frequencies or levels. If this automatic expiration date is amended (in whatever way the EPA determines is appropriate at the time), it shall not be amended to a date later than November 9, 2021, by which date this registration will automatically expire unless the EPA determines before that date that

herbicide resistance to dicamba is not occurring at unacceptable frequencies or levels, and that off-site incidents are not occurring at unacceptable frequencies or levels.

E. Geographic Limitation on Use of Dicamba M1768 Herbicide

The EPA is issuing these new uses only to be sold and used in Alabama, Arizona, Arkansas, Colorado, Delaware, Florida, Georgia, Illinois, Iowa, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

^[1] Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., Bradley, K. W., Frisvold, G., Powles, S. B., Burgos, N. R., Witt, W. W., Barrett, M. 2012. Reducing the risks of herbicide resistance: Best Management Practices and Recommendations. Weed Science Special Issue: 31-62. <http://wssajournals.org/doi/pdf/10.1614/WS-D-11-00155.1>



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

November 9, 2016

Dr. James Nyangulu
U.S. Agency Regulatory Affairs Manager
Monsanto Company
1300 I St., NW
Washington, DC 20005

Subject: PRIA Label Amendment – Adding new uses on dicamba-resistant cotton and soybeans
Product Name: M1768 Herbicide
Alternate Brand Name: Xtendimax™ with VaporGrip™ Technology
EPA Registration Number: 524-617
Application Dates: 10/21/2016, 4/12/2016, and 11/19/2015, respectively
Decision Number: 522837, 516207, and 511766

Dear Dr. Nyangulu:

1. The application referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide and Rodenticide Act, as amended, is acceptable under FIFRA Section 3(c)(7)(B) subject to the following conditions:
2. You must submit and/or cite all data required for registration/reregistration/registration review of your product under FIFRA when the Agency requires all registrants of similar products to submit such data.
3. Be aware that proposed data requirements have been identified in a Preliminary Work Plan under Docket ID EPA-HQ-OPP-2016-0223-0010 at www.regulations.gov . For more information on these proposed data requirements, you may contact the Chemical Review Manager in the Pesticide Re-Evaluation Division.
4. This registration will automatically expire on 11/09/2018.
5. You must maintain a website at <http://Xtendimaxapplicationrequirements.com>. That website will include a list of products that have been tested pursuant to Appendix A and found, based upon such testing, not to adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology. The website will identify a testing protocol, consistent with Appendix A, that is appropriate for determining whether the tested product will adversely affect the drift properties of Xtendimax™ with VaporGrip™ Technology. . The website will state that any person seeking to have a product added to the list must perform a study either pursuant to the testing protocol identified on the website or another protocol that has been approved for the particular

purpose by EPA, and must submit the test data and results, along with a certification that the studies were performed either pursuant to the testing protocols identified on the website or pursuant to another protocol(s) approved by EPA and that the results of the testing support adding the product to the list of products tested and found not to adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology, to EPA. EPA will notify you when the Agency determines that a product has been certified to be appropriately added to the list, and you will add appropriately certified products to the list no more than 90 days after you receive such notice from EPA. Testing of Tank-Mix Products must be conducted in compliance with procedures as stated forth in Appendix A.

6. All test data relating to the impact of tank-mixing any product with Xtendimax™ with VaporGrip™ Technology on drift properties of Xtendimax™ with VaporGrip™ Technology generated by you or somebody working for you must be submitted to EPA, along with a certification indicating whether the study was performed either pursuant to the testing protocols identified on the website or pursuant to other protocols approved by EPA and whether the results of the testing support adding the product to the list of products tested and found not to adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology, at the following address: Chief of Environmental Risk Branch 1, Environmental Fate and Effects Division, Office of Pesticide Programs. If the certification states that the study was performed either pursuant to the testing protocol identified on the website or pursuant to another protocol approved by EPA, and the results of the testing support adding the product to the list of products tested and found not to adversely affect the spray drift properties of Xtendimax™ with VaporGrip™, you may add the product to the list.
7. The prohibition of using products in a tank-mix with Xtendimax™ with VaporGrip™ Technology unless the product used is contained on the list at Xtendimaxapplicationrequirements.com, and the identification of the website address, shall be included in educational and information materials developed for Xtendimax™ with VaporGrip™ Technology, including the materials identified in Appendix D, Section B(1).
8. You must develop and follow an Herbicide Resistance Management Plan (HRM) as laid out in Appendix D regarding grower agreements, field detection and remediation, education, evaluation, reporting, and best management practices (BMPs).

A stamped copy of your labeling is enclosed for your records. This labeling supersedes all previously accepted labeling. You must submit one (1) copy of the final printed labeling before you release the product for shipment with the new labeling. In accordance with 40 CFR 152.130(c), you may distribute or sell this product under the previously approved labeling for 18 months from the date of this letter. After 18 months, you may only distribute or sell this product if it bears this new revised labeling or subsequently approved labeling. "To distribute or sell" is defined under FIFRA section 2(gg) and its implementing regulation at 40 CFR 152.3.

Should you wish to add/retain a reference to the company's website on your label, then please be aware that the website becomes labeling under the Federal Insecticide Fungicide and Rodenticide Act and is subject to review by the Agency. If the website is false or misleading, the product would be misbranded and unlawful to sell or distribute under FIFRA section 12(a)(1)(E). 40 CFR 156.10(a)(5) list examples of statements EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the Agency find or if it is brought to our attention that a website contains false or misleading statements or claims substantially differing from the EPA approved registration, the website will be referred to the EPA's Office of Enforcement and Compliance.

Your release for shipment of the product constitutes acceptance of these conditions. If you fail to satisfy these data requirements, EPA will consider appropriate regulatory action including, among other things, cancellation under FIFRA section 6(e). If you have any questions, please contact Grant Rowland by phone at 703-347-0254, or via email at Rowland.grant@epa.gov.

Sincerely,

A handwritten signature in black ink, appearing to read 'D. Kenny', with a long horizontal flourish extending to the right.

Daniel Kenny, Chief
Herbicide Branch
Registration Division (7505P)
Office of Pesticide Programs

Enclosure

APPENDIX A

Testing of Tank Mix Products for Spray Drift Properties

Products proposed for tank-mixing with may be added to the list of products that will not adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology contained on the web site if a study is performed under the testing conditions set forth below; the test information is reported as set forth below; and the results are interpreted as set forth below and the interpretation supports adding the tested product to the list of products that will not adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology:

Testing Conditions

Spray chamber test using conditions described in ASTM E-2798-11; or Wind Tunnel test using conditions described in EPA Final Generic Verification Protocol for Testing Pesticide Application Spray
Drift Reduction Technologies for Row and Field Crops (September 2013)

Testing Media: Xtendimax™ with VaporGrip™ Technology + Xtendimax™ with VaporGrip™ Technology Proposed Tank Mix Product

Test Nozzle: Tee Jet® TTI 11004 at 63 psi

Number of Replicates: 3 for each tested medium

Reporting

Validation information as summarized in Appendix B

Full droplet spectrum to be reported for each replicate of each tested medium

Perform AGDISP (8.26) modeling run for each replicate droplet spectrum for each tested medium (AGDISP input parameters described in Appendix C)

Establish 110 foot (0.5 lb ae/A rate) or 220 foot (1.0 lb ae/A rate) spray drift deposition estimates from AGDISP run on each replicate for each tested medium

Establish mean and standard deviation of 110 foot (0.5 lb ae/A rate) or 220 foot (1.0 lb ae/A rate) deposition for the 3 replicates of each tested medium

One-tail (upper bound) t-test ($p=Q.1$) to determine if proposed tank-mix product is above Xtendimax™ with VaporGrip™ Technology 110 foot (0.5 lb ae/A rate) or 220 foot (1.0 lb ae/A rate) spray drift deposition

Interpretation of Results

If mean 110 foot (0.5 lb ae/A rate) or 220 foot (1.0 lb ae/A rate) deposition for proposed tank-mix product is not statistically greater than mean 110 foot deposition for Xtendimax™ with VaporGrip™ Technology, proposed tank-mix product can be added to the list of products that will not adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology contained on the web site. If mean 110 foot (0.5 lb ae/A rate) or 220 foot (1.0 lb ae/A rate) deposition for proposed tank-mix product is statistically greater than mean 110 foot (0.5 lb ae/A rate) or 220 foot (1.0 lb ae/A rate) deposition for Xtendimax™ with VaporGrip™ Technology, proposed tank-mix product cannot be added to the list of products that will not adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology contained on the web site.

Results from other testing protocols will be acceptable for adding products to the list of products that will not adversely affect the spray drift properties of Xtendimax™ with VaporGrip™ Technology provided that EPA has determined in writing that such other protocol is appropriate for such purpose.

APPENDIX B

Validation Criteria

- a. Detailed information of instrument setting and measurements
 - The distance from the nozzle tips to the laser settings
 - Measurements of airspeed and flow rate of liquid
- b. Detailed information of test substances
 - Volume composition and density of Xtendimax™ with VaporGrip™ Technology formulation and tank mixes
- c. Summary of the entire spray output distribution for each nozzle/tank mixes with statistical analysis of replicates.
- d. Graphical outputs of Sympatec Helos laser diffraction particle size analyzer FOR individual spectrum

Report of Dv0.1 (SD), Dv0.5 (SD), and DV0.9 (SD) as well as mean % fines of (< 141pm SD)

APPENDIX C AGDISP Input Parameters

Parameter	Value	Comments
Application Method Section		
Method	Ground	
Nozzle Type	Flat fan (Default)	The direct use of the DSD overrides the use of “nozzle type”
Boom Pressure	63 psi	If nozzles/tank mixes were tested at 63 psi. It has to be consistent with tank mix as well as Xtendimax™ with VaporGrip™ Technology for both TeeJet® and AIXR nozzles
Release Height	3 ft	Default
Spray Lines	20	Default
Meteorology Section		
Wind Type	Single height	Default
Wind Speed	15 mph	Under bound from label
Wind Direction	-90 deg	Worst-case and default
Temperature	65 F	Default
Relative Humidity	50%	Default
Surface Section		
Angles	0	Default
Canopy	None	Default
Surface Roughness	0.12 ft	Mean of “crops” cover type
Application Technique Section		
Nozzles	54, even spacing	Standard boom setup
DSD	From wind tunnel results, imported in library	
Atmospheric stability	Strong	Default
Swath Section		
Swath width	90 ft	Standard boom
Swath displacement	0 ft	Worst-case
Spray Material Section		
Spray volume rate	10 gal/A	From label
Volatile/nonvolatile fraction	M 1768 at 1.72% v/v	To calculate volatile/nonvolatile fraction in the tank mix for the model input, provide detailed information of the tested formulations and tank mixes. See sample calculation, below ¹
¹ The tested mixture was 1.72% (v/v) M-1768. M-1768 has a density of 10.2 lb/gal and contains 42.8% (w/v) dicamba DGA salt (2.9 lb acid equivalent/gal). For example, a 10-gallon batch would contain the following: M-1768 1.71% * 10 gal = 0.172 gal ; 0.172 gal * 10.2 lb/gal = 1.753 lb Water 10 gal (1280 fl oz) – 22 fl oz = 1258 fl oz = 82.0157 lb Total weight 1.753 lb + 82.016 lb = 83.769 lb Active ingredient fraction: 1.753 lb * 42.8% a.i. = 0.75 lb; 0.75 lb/83.769 lb = 0.00896 (dimensionless) Non-volatile fraction: 0.00896/0.428 = 0.021 (dimensionless)		

APPENDIX D

HERBICIDE RESISTANCE MANAGEMENT PLAN

Monsanto (MON) must:

A. Field Detection and Remediation Components:

1. Develop and implement an education program for growers, as set forth under the “Educational / Informational Component,” below, that identifies appropriate best management practices (BMPs), as set forth under the “Best Management Practices (BMPs) Component,” below, to avoid and control weed resistance, and that conveys to growers the importance of complying with BMPs. Such BMPs shall include that fields must be scouted after application to confirm herbicide effectiveness, and that users should report any incidence of lack of efficacy of this product against a particular weed species to Monsanto or a Monsanto representative.
2. If any grower informs you of a lack of herbicide efficacy, then you or your representative must make an effort to evaluate the field for “likely resistance” to M1768 herbicide for each specific species for which lack of herbicide efficacy is reported by applying the criteria set forth in Norsworthy, *et al.*, “Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations,” *Weed Science* 2012 Special Issue:31–62 (*hereinafter* “Norsworthy criteria”)¹ in each specific state until resistance to dicamba is confirmed for a specific weed species in that state using acceptable scientific methods. However, for each grower, you must continue to provide stewardship about resistance management throughout their use of this product. If resistance to dicamba is confirmed in a specific state for a specific weed species, then MON must immediately report such confirmation to EPA and need no longer investigate reports of lack of herbicide efficacy regarding that specific species in that specific state, but MON must continue to make an effort to help address lack of herbicide efficacy regarding any other weed species in any such state;
3. Keep records of all field evaluations for “likely resistance” for a period of 3 years, and make such copies available to EPA upon request; and
4. If one or more of the Norsworthy criteria are met, then for a weed species not already confirmed to be resistant to dicamba in that specific state, Monsanto will:
 - a. Provide the grower with specific information and recommendations to control and contain likely resistant weeds, including retreatment and/or other non-chemical controls,

¹ The Norsworthy “likely herbicide resistance” criteria are: (1) failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds; or (2) a spreading patch of uncontrolled plants of a particular weed species; or (3) surviving plants mixed with controlled individuals of the same species. The identification of any of these criteria in the field indicates that “likely herbicide resistance” is present.

as appropriate. If requested by the grower, MON or their agent will become actively involved in implementation of weed control measures;

- b. Request, at the time of the initial determination that one or more of the Norsworthy criteria are met and prior to any application of alternative control practices, that the grower provide you with access to the relevant field(s) to collect specimens of the likely resistant weeds (potted specimens or seeds) for further evaluation in the greenhouse or laboratory, and so collect such specimens if possible (or, alternatively, request that the grower provide such specimens to you, at your expense);
- c. Commence greenhouse or laboratory studies to confirm resistance as soon as practicable following sample collection;
- d. To the extent possible, contact or visit the grower in an appropriate timeframe after implementation of the additional weed control measures in order to evaluate success of such measures; and
- e. If the additional weed control measures were not successful in controlling the likely resistant weeds, then:
 - i. Work with the grower to determine the reason(s) why the additional control measures were not successful;
 - ii. Report annually the inability to control the likely resistant weeds to relevant stakeholders; and
 - iii. Offer to further assist the grower in controlling and containing the likely resistant weeds, including retreatment and/or other non-chemical controls, as appropriate.

B. Educational / Informational Component:

1. Develop and implement an education program for growers that includes the following elements:
 - a. The education program shall identify appropriate best management practices (BMPs), set forth under the “Best Management Practices (BMPs) Component,” below, to avoid and control weed resistance, and shall convey to growers the importance of complying with BMPs;
 - b. The education program shall include at least one written communication regarding herbicide resistance management each year, directed to users of M1768 herbicide for use over-the-top on dicamba tolerant soybean or cotton; and
 - c. You must make the education program available to MON sales representatives for distribution to growers.
2. Provide to EPA the original education program within three months of the issuance of this registration.

C. Evaluation Component:

1. Monsanto will annually conduct a survey directed to users of M1768 herbicide for use over-the-top of dicamba tolerant soybean or cotton. This survey must be based on a statistically representative sample. The sample size and geographical resolution should be adequate to allow analysis of responses within regions, between regions, and across the United States. This survey shall evaluate, at a minimum, the following:
 - a. Growers' adherence to the terms of the M1768 Use Directions and Label Restrictions, and
 - b. Whether growers have encountered any perceived issue with non-performance or lack of efficacy of M1768 herbicide and, if so, how growers have responded.
2. Utilize the results from the survey described in paragraph 1 of this section to annually review, and modify as appropriate for the upcoming growing season, the following:
 - a. Efforts aimed at achieving adoption of BMP's;
 - b. Responses to incidents of likely resistance and confirmed resistance; and
 - c. The education program. At the initiative of either EPA or MON, EPA and MON shall consult about possible modifications of the education program.

D. Reporting Component:

1. Submit annual reports to EPA by January 15 of each year, beginning on January 15, 2018. Such reports shall include:
 - a. Annual sales of M1768 herbicide by state;
 - b. The first annual report shall include the current education program and associated materials, and subsequent annual reports shall include updates of any aspect of the education program and associated materials that have materially changed since submission of the previous annual report;
 - c. Summary of your efforts aimed at achieving implementation of BMP's;
 - d. Summary of your determinations as to whether any reported lack of herbicide efficacy was "likely resistance," your follow-up actions taken, and, if available, the ultimate outcome (e.g., evaluation of success of additional weed control measures) regarding each case of "likely resistance." In the annual report, MON will list the cases of likely resistance by county and state.
 - e. The results of the annual survey described in paragraph 1 under "Evaluation Component," above, including whether growers are implementing herbicide resistance

BMPs, and a summary of your annual review and possible modification – based on that survey – of the education program, , and response to reports of likely resistance, described in paragraph 2 under “Evaluation Component,” above; and

- f. Summary of the status of any laboratory and greenhouse testing performed by, or at the direction of, Monsanto following up on incidents of likely resistance, performed in the previous year. Data pertaining to such testing need not be included in the annual reports, but such data must be made available to EPA upon request.
1. Following your submission of the annual report, you shall meet with the EPA at EPA’s request in order to evaluate and consider the information contained in the report.
- 2.

E. Best Management Practices (BMPs) Component:

1. Best management practices (BMPs) must be identified in your education program. Growers will be advised of BMP’s in product literature, educational materials and training. The following are examples of BMPs:
 - a. Regarding crop selection and cultural practices:
 - i. Understand the biology of the weeds present.
 - ii. Use a diversified approach toward weed management focused on preventing weed seed production and reducing the number of weed seeds in the soil seed-bank.
 - iii. Emphasize cultural practices that suppress weeds by using crop competitiveness.
 - iv. Plant into weed free fields, keep fields as weed free as possible, and note areas where weeds were a problem in prior seasons.
 - v. Incorporate additional weed control practices whenever possible, such as mechanical cultivation, biological management practices, crop rotation, and weed-free crop seeds, as part of an integrated weed control program.
 - vi. Do not allow weed escapes to produce seeds, roots or tubers.
 - vii. Manage weed seed at harvest and post-harvest to prevent a buildup of the weed seed-bank.
 - viii. Prevent field-to-field and within-field movement of weed seed or vegetative propagules.
 - ix. Thoroughly clean plant residues from equipment before leaving fields.
 - x. Prevent an influx of weeds into the field by managing field borders.
 - xi. Fields must be scouted before application to ensure that herbicides and application rates will be appropriate for the weed species and weed sizes present.

- xii. Fields must be scouted after application to confirm herbicide effectiveness and to detect weed escapes.
- xiii. If resistance is suspected, treat weed escapes with an alternate mode of action or use non-chemical methods to remove escapes.

b. Regarding herbicide selection:

- i. Use a broad spectrum soil applied herbicide with a mechanism of action that differs from this product as a foundation in a weed control program.
- ii. A broad spectrum weed control program should consider all of the weeds present in the field. Weeds should be identified through scouting and field history.
- iii. Difficult to control weeds may require sequential applications of herbicides with alternative mechanisms of action.
- iv. Fields with difficult to control weeds should be rotated to crops that allow the use of herbicides with alternative mechanisms of action.
- v. Apply full rates of this herbicide for the most difficult to control weed in the field. Applications should be made when weeds are at the correct size to minimize weed escapes.
- vi. Do not use more than two applications of this herbicide or any herbicide with the same mechanism of action within a single growing season unless mixed with another mechanism of action herbicide with overlapping spectrum for the difficult to control weeds.
- vii. Report any incidence of lack of efficacy of this product against a particular weed species to Monsanto or a Monsanto representative.

This list may be updated or revised as new information becomes available.

Appointment

From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
Sent: 3/7/2016 11:03:01 PM
To: Rowland, Grant [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=5b004bc79f1f40b0a181a584a8c64495-Rowland, Grant]; Baris, Reuben [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a0181e3f02a246fc915a4af026e249fc-Baris, Reuben]; Schmid, Emily [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0c06b35a5f814370b9a92d394f969332-Hartman, Emily]; Kenny, Daniel [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1be9bb592f144269bcd41dd3a6d8a6d4-Daniel C. Kenny]; Montague, Kathryn V. [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c50d485150734f6e85059d64dd80a353-Kathryn V. Montague]
Subject: Dicamba: EFED RA and ESA section discussion
Attachments: Final Registration of Enlist Duo Herbicide - 10-14-14.doc; EFED original RA - Dicamba Soybean.pdf; Dicamba Soybean EFED addendum #1.pdf; Dicamba Soybean Addendum #2 (includes drift, volate, incidence).docx; Dicamba_ESA Phase 1 3-3-16_CLEANmlk_bjw-03-07-16.docx; Dicamba Phase 2 States ESA Assessment_12-10-15.docx; Phase 3+4 States ESA Assessment_12-10-15.docx; Dicamba Cotton RA (includes drift, volate, incidence (draft).docx
Location: DCRoomPYS7621B/Potomac-Yard-One
Start: 3/9/2016 6:00:00 PM
End: 3/9/2016 7:00:00 PM
Show Time As: Busy

[Final Registration of Enlist Duo Herbicide - 10-14-14.doc](#) [EFED original RA - Dicamba Soybean.pdf](#) [Dicamba Soybean EFED addendum #1.pdf](#) [Dicamba Soybean Addendum #2 \(includes drift, volate, incidence\).docx](#) [Dicamba ESA Phase 1 3-3-16_CLEANmlk_bjw-03-07-16.docx](#) [Dicamba Cotton RA \(includes drift, volate, incidence \(draft\).docx](#) [Dicamba Phase 2 States ESA Assessment 12-10-15.docx](#) [Phase 3+4 States ESA Assessment 12-10-15.docx](#)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

PC Code: 128931

DP Barcode: 404138, 404806, 405887, 410802, 411382

May 20, 2013

MEMORANDUM

SUBJECT: Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean

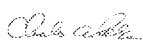
TO: Kathryn Montague, Risk Manager (RM 23)
Daniel Kenny, Branch Chief, Herbicides Branch
Registration Division (7505P)

FROM: Elizabeth Donovan, Biologist
Reuben Baris, Environmental Scientist
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Elizabeth Donovan
DN: cn=Elizabeth Donovan, o=EPA, ou=EFED,
email=donovan.elizabeth@epa.gov, c=US
Date: 2014.05.20 08:29:33 -04'00'
Digitally signed by Baris, Reuben
DN: cn=Baris, Reuben,
email=Baris.Reuben@epa.gov
Date: 2014.05.20 12:00:52 -04'00'

THRU: Mark Corbin, Branch Chief
Environmental Risk Branch VI
Environmental Fate and Effects Division (7507P)

Digitally signed by Mark Corbin
DN: cn=Mark Corbin, o=USEPA, ou=EFED,
email=corbin.mark@epa.gov, c=US
Date: 2014.05.20 12:42:48 -04'00'

REVIEWED Charles Peck, Physical Scientist  2014.05.20 12:17:22 -04'00'

BY: Faruque Khan, Ph.D., Physical Scientist  2014.05.20 12:59:01 -04'00'
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708) (DP Barcode 378444; dated March 8, 2011) did not include complete evaluation of risks to terrestrial non-target organisms exposed to dicamba through spray drift and vapor drift. This analysis was not included because there was incomplete information on the drift and volatility of the diglycolamine salt of dicamba (DGA) relative to the acid as well as a lack of information on the toxicity of vapor phase dicamba (DGA or acid) to terrestrial plants. Without this information EFED was not able to conduct a quantitative risk assessment for plants exposed to dicamba spray drift or vapor drift. Recent data submitted to the Agency by the registrant, Monsanto Company (Monsanto), provided sufficient information to

support a more thorough analysis of spray drift and vapor drift exposure to plants. While this additional information does not allow for a full characterization of off-field movement of dicamba, conservative assumptions can be made for vapor emitted from the application site as well as assumptions for spray drift to estimate ecological risk from both of these exposure routes. Available information and additional analyses are presented below.

In addition, as discussed in the Addendum to the Data Evaluation Report on the Toxicity of Clarity 4.0 SL (AI: Dicamba) to Terrestrial Vascular Plants: Vegetative Vigor (MRID 47815102; D411301; dated April 25, 2013), use of the EC_{05} (0.000013 lb a.e./A) is not appropriate for the listed species risk assessment because a NOAEC value of 0.000261 lb a.e./A is available. Based on this information, the terrestrial plant assessment has been updated to reflect the most current endpoints. Additionally, the terrestrial invertebrate assessment has been updated based on changes in Agency policy.

Based on the weight of evidence analysis included in this addendum the dominant route of off-field exposure to non-target terrestrial and aquatic organisms is more likely to be a result of spray drift and runoff than the volatilized mass of dicamba from a treated field. This does not mean that volatility is not a concern; however, spray drift and run-off are more dominant routes of exposure. The first tier estimated distances where effects are predicted for non-target organisms from the treated field (0.5 lb a.e./A) are 210 and 475 feet for the non-listed and listed terrestrial plant endpoints, respectively (410 and 890 ft for the 1.0 lb a.e./A application, non-listed and listed species, respectively). Conclusions are based on the analysis of coarse droplet spectra data from the Spray Drift Task Force (SDTF) and the estimated deposition off field above the non-listed and listed terrestrial plant endpoints. A different 100 ft buffer distance is proposed by Monsanto based on an alternative method for estimating distance to no effect off-field (see analysis below for spray drift analysis). However, there is uncertainty about how specific spray drift reduction strategies (*e.g.*, DRT and nozzle/product specific labeling language) impact the distance of effects off-field. This is largely due to a lack of data.

Additional analyses were conducted with available data and additional submissions provided by Monsanto aimed at refining the initial estimates of buffer distances; however, the following uncertainties persist:

- Product and nozzle specific drift curves are not available.
- The Theoretical Shape Profile (TSP) method study submitted by Monsanto provided a line of evidence about the volatility of dicamba, however it is uncertain how this compares to standard field volatility studies (OCSPP guideline number 835.8100).
- A vapor phase toxicity endpoint is not available for terrestrial plants to compare to the estimates of vapor exposure.

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. For the over-the-top 0.5 lb a.e./A application rate, a realistic distance from the application site to where no effects are observed ranges from 100-175 ft (assuming linearity, the 1.0 lb a.e./A rate would presumably yield roughly 2x greater distances). However, based on the weight of evidence for

the coarser droplet spectra, and a 0.5 lb a.e./A rate, this distance is 125 ft. * Distances for the 1.0 lb a.e./A rate are roughly 2x the distance estimated for the 0.5 lb a.e./A rate assumptions are linear.

Of paramount importance, product and nozzle specific drift curves based on empirical data are needed to address uncertainties with the distance off-field that effects are estimated for terrestrial plants. These type of data should be consistent with the Agency's Drift Reduction Technology (DRT) program intending to improve the clarity and enforceability of product label use directions and drift restrictions and encourage the use of drift reducing application technologies and best management practices to minimize drift. Results from DRT studies can be incorporated into specific label use directions and drift restrictions that would better inform the spray drift risk assessment and would likely result in smaller estimated buffer distances between the treated field and non-target organisms.

Updates to Conclusions from Previous Terrestrial Plant Assessment

Dicamba exposure to terrestrial and semi-aquatic plants, estimated using the TerrPlant model (version 1.2.2), resulted in RQs that exceeded the listed and non-listed species level of concern (LOC = 1) for dicots in terrestrial areas due to spray drift and in semi-aquatic areas due to runoff and spray drift. RQs for monocots in terrestrial and semi-aquatic areas did not exceed the LOC. The EECs, toxicity endpoints, and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 1-3**.

Table 1. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A) Ground Spray		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 2. Plant survival and growth data used for RQ derivation. Units are in lb a.e./A.

Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.427	0.137
Dicot	0.123	0.0673	0.000513	0.000261

Table 3. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

* Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	38.31
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

Updates to Conclusions from Previous Terrestrial Invertebrate Assessment

T-REX is used to calculate EECs for terrestrial invertebrates exposed to the DGA salt of dicamba from the proposed use on dicamba-tolerant soy. Terrestrial EECs for the DGA were derived for the proposed use based on the maximum labeled application rate (*i.e.*, 1.0 lb a.e./A application followed by two 0.5 lb a.e./A applications at 6 day intervals). The foliar dissipation half-life of 35 days is used based on the T-REX user guide. The dietary-based EEC calculated by T-REX for arthropods (units of $\mu\text{g a.e./g}$ of bee, or ppm) are used to estimate exposure to terrestrial invertebrates. The EECs are compared to the adjusted acute contact toxicity data for bees in order to derive RQs. For dicamba, the available acute contact toxicity endpoint for bees exposed to dicamba (in units of $\mu\text{g a.e./bee}$), is converted to $\mu\text{g a.e./g}$ (of bee) by multiplying 1 bee by 0.128 g (the average weight of an adult honey bee). In this case, the acute contact LD_{50} is $> 91 \mu\text{g a.e./bee}$ for the honey bee (*Apis mellifera*, MRID 00036935), which results in an adjusted toxicity value of $>711 \mu\text{g a.e./g}$ of bee.

While RQs cannot be calculated for terrestrial invertebrates because of the non-definitive toxicity endpoint, EECs generated for the arthropod can be compared to the available toxicity data to determine whether there is potential for risk. The arthropod EEC for dicamba is $162.85 \mu\text{g a.e./g}$ of bee, which represents 23% of the highest dose tested in the acute contact study. To further put potential exposures in context, the highest concentration tested in the available acute contact study, which did not result in mortality or signs of overt toxicity, is already below the Agency's interim LOC (0.4). Based on this information, the risks to listed and non-listed terrestrial invertebrates from the proposed use of dicamba is low.

Additional Analyses

Field Studies

The registrant submitted additional information in support of their request for registration of the DGA salt for use on Dicamba-tolerant soybean (MON 87708).

The first study (MRID 48892301) measured the effects of small amounts of MON 54140, a technical end use product with the DGA salt, on soybean vegetative growth and yield endpoints under field conditions. Soybean was selected as the test species in part because available lab data suggest it is highly sensitive to dicamba during vegetative growth stages with NOAEC and EC_{25} values of 0.000261 and 0.000513 lb a.e./A, respectively (MRID 47815102; Acceptable). During the study, MON 54140 was applied to plants at three field sites within the major soybean growing region (AR1 located in Proctor, Arkansas, IL1 located in Carlyle, IL, and IL2 located in Wyoming, IL). Six spray application rates plus a control were used and plant responses were

measured weekly for nine weeks. The study authors calculated EC_x values for each week of measurement and determined that plant effects peaked three weeks after pesticide application. The most sensitive endpoint across the three sites was plant height, with the lowest EC₂₅ and associated NOAEC values of 0.0008 lb a.e./A and less than 0.0006 lb a.e./A, respectively. Results of this study support the contention that soybean in the field showed similar sensitivity to dicamba as soybean in the lab and can thus be used as a field bioassay.

The second study (MRID 48876001) addressed the potential for off-site movement of the DGA salt under field conditions using non-tolerant soybean as a bioassay. The study was conducted under varying field conditions to represent a range of application scenarios possible for the proposed new use on dicamba tolerant soybean. MON 54140 was applied at a rate of 0.5 lb a.e./A to the eight field sites using TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles. Applications were made perpendicular to the prevailing wind direction to maximize the potential for spray drift. Plant heights were measured at regular intervals up to 328 ft downwind of the spray areas depending on the size and shape of the experimental field. There were no controls in this study so statistic could not be verified using standard EFED approaches. Instead, mean no-effect distances were determined by fitting non-linear mixed effects model to the available plant height data and calculating an effective distance. For those transects that did not fit the non-linear mixed effects model, mean no-effect distances were visually determined from scatterplots for each transect. The overall mean no-effect distance based on reduction in plant height was less than 90 ft for all trials. This study forms the basis for the registrant's recommendation of a 100 ft buffer for 0.5 lb a.e./A applications of the DGA salt to dicamba tolerant soybean. The study was reviewed in conjunction with the Statistics Technical Team (STT) and the following uncertainties were noted:

- Control plants were not used in this study, necessitating use of non-standard statistical methods.
- Outliers in the data, defined as “an observation at a distance along a transect at which the maximum plant height was greater than two times the minimum plant height”, were removed from the analysis to calculate no-effect distances. These outliers may represent sensitive plants and may have an impact on the calculated no-effect distances.
- The analysis used PROC NLMIXED in SAS to fit the nonlinear regression model for each transect rather than running a single nonlinear mixed effects model accounting for all of the effects of the study (e.g., site, transect, nozzle type), which would better assess potential sources of variability.
- The analysis reports the mean no effect distance for each site and nozzle combination instead of the upper 90th confidence interval, which would better represent possible exposures.

The STT expressed reservations about the overall study design (e.g., the lack of control data) and were uncertain whether the results are meaningful given the amount of variability inherent in terrestrial plant field studies. It is the team's opinion that results of the study should be interpreted with caution.

Drift Analysis

An analysis of the Coarse Droplet data from Spray Drift Task Force[†] (SDTF) showed that exceedances of the non-listed terrestrial plant endpoint could occur up to 210 ft and 410 ft from the edge of field using max single rate and max in-crop app rate of 0.5 and 1.0 a.e./A, respectively. These distances were calculated using an approved method for estimating spray drift for Agency risk assessment where the non-listed EC₂₅ vegetative vigor endpoint for soybeans was used (0.000513 lbs a.e./A, MRID 47815102) as well as the 90th percentile of the coarse droplet size distribution (DSD) for spray drift. There was no exceedance for monocot plant species, only dicot plant species. For listed plants, there are exceedances up to 475 ft from the edge of field for the 0.5 lb a.e./A maximum single application rate, and 890 ft from the edge of field for the 1.0 lb a.e./A rate. Calculations of distances of effect are based on the vegetative vigor endpoint for soybean (NOAEC = 0.000261 lb a.e./A) (**Table 4**). This analysis was completed using the 90th percentile of the coarse DSD from the empirical data that forms the basis for the AgDRIFT model. The low-boom, coarse DSD was extracted and each of the 4 swaths were plotted. For each run, values were ranked and the 90th percentile was selected for this analysis. The 90th percentile deposition with distance was plotted and estimated distances where off field effect are likely to be minimized were calculated based on the fraction of droplet deposition.

Additional characterization of the potential spray drift using the 50th percentile deposition curve would result in buffer distances of approximately 125 and 250 ft for the 0.5 lb a.e./A rate and the non-listed and the listed endpoint, respectively (**Table 5**). In order to further refine these modeled distances where effects off field are minimized, product- and nozzle-specific drift curves are needed.

Table 4. Estimated distance off field effects for non-target species observed based on Coarse DSD from 90th %-tile SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	210 ft	410 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	475 ft	890 ft

Table 5. Estimated distance off field effects for non-target species observed based on Coarse DSD from 50th %-tile* SDTF data (4-swaths).

Vegetative Vigor Endpoint	Application Rate	
	0.5 lbs a.e./A (max single app in crop)	1.0 lbs a.e./A (total in crop)
Dicot, soy (non-listed, EC ₂₅ = 0.000513 lbs a.e./A)	125 ft	250 ft
Dicot, soy (listed, NOAEC = 0.000261 lbs a.e./A)	250 ft	425 ft

* Note: 50th %-tile DSD is a non-standard approach that is not typically used for spray drift modeling as it may under predict potential driftable fines.

Characterization of Spray Drift Analysis

[†] Teske et al., 2001

The Agency continues to reevaluate approaches to estimating spray drift off-field from the treatment site. In the case of this DGA assessment, a weight of evidence approach was used to refine standard AgDRIFT estimates of spray drift to calculate distance to no-effect for listed and non-listed dicot plant species. Appendix A includes a tabulation of the available data (submissions) and individual model estimates of buffer distances, which are described below. The buffer distance based on the analysis of the weight of evidence for the 0.5 lb a.e./A application rate is 125 ft.[‡] However, product and nozzle-specific drift curves based on empirical data that are incorporated into specific label use directions and buffer restrictions and would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

EFED explored several refinements to the standard conservative assumptions built into standard modeling approaches to characterize potential off-field exposure from spray drift. First, AgDRIFT SDTF data, which contain empirical data based on 4 swaths, were compared to modeled data based on 1 swath. The result at the 90th percentile DSD for the 0.5 lb a.e./A is 175 ft and 300 ft for the 1.0 lb a.e./A from the treated field to no-effect for listed species, compared to 475 and 890 ft discussed above using a 4 swath analysis (a 300 ft and almost 600 ft reduction if a single swath analysis is used). This approach accounts for the impact of a single pass within the field and the resulting estimated drift off field, however a single swath scenario is not realistic given the application practices in soy agriculture.

Second, a crude approach looks at all of the available data and averages all distances together, equaling approximately 175 ft as the distance beyond which effects to listed plant species are not expected. Extracting just the coarse, extra-coarse, and ultra-coarse values from this table the average is reduced to 124 ft (which is rounded to 125 ft). Additionally, examining the extra-coarse and ultra-coarse data points exclusively in the weight of evidence result in an estimated average distance of 107 ft. All of the methods for estimating spray drift and distances to no-effect use different assumptions and thus aggregating them together should be done with caution. However, this analysis highlights the range in potential variability (62-475 ft) when estimating the distance off field below the where deposition is less than the NOAEC. Again to address the identified uncertainties a study that evaluates the product and nozzle specific recommendations according to the American Society of Biological and Agricultural Engineers (ASABE) DSD could be submitted to inform the distance to no-effect, in all likelihood reducing the potential buffer distance.

Part of the weight of evidence approach includes additional study submissions by Monsanto. These studies include an independent analyses of spray drift using the AgDRIFT Model and field investigations titled, *Summary of Investigations of the Potential for Off-Site Movement through the Air of the Herbicide MON 54140 Following Ground Applications* (MRID 48876001) and *Concordance of MON 54140 Buffer Distances Determined using Field Spray Drift Studies and AgDRIFT* (MRID 49022404). The purpose of these submissions was to present the results of eight field trials in the US and Argentina, designed to evaluate off-site movement of dicamba from fields treated with the DGA formulation and compare those results to AgDRIFT modeling.

[‡] Modeled estimates for 1.0 lb a.e./A are approximately 2x the 0.5 lb a.e./A rate, therefore it is reasonable to assume the weight of evidence distance is 250 ft.

The trials were conducted under varying field conditions to represent a range of application scenarios including applications with and without a glyphosate formulation. Spray solutions were applied using either TeeJet AIXR 11004, TTI 11004, or AIC 11003 nozzles at nominal dicamba rates of 0.5 lb a.e./A to plots of soybeans or corn contained within larger soybean fields. In the study submitted by Monsanto (MRID 48876001) results of field trials were compared with AgDRIFT model runs using the 50th-tile DSD with an incorporation of an adjustment to the driftable fines fraction obtained from wind tunnel test. Based on results from this analysis, combined with the submitted field data, Monsanto concluded that a distance of approximately 100 ft would be needed to reduce potential effects to non-target sensitive plants. Note Monsanto also completed a comparison of AgDRIFT model runs using the 90th-tile DSD resulting in an average of 40 ft greater no-effect distance for the 90th-tile DSD runs.

To provide additional support for the 100 ft buffer recommended by the various field trials, Monsanto submitted an analysis using the PMRA Buffer Zone Workbook and the underlying data supporting the tool (D405887). A review of these data were completed and were included in the weight of evidence approach (USEPA, 2013).

The Agency's conclusions and approaches to estimating buffer distances are different than Monsanto's. Ultimately the Agency disagrees with the application of the correction factor for driftable fines based on wind tunnel data. The Agency's analysis of the driftable fraction (% <150µm) that underlies the AgDRIFT model is 9.5% compared to the 15.63% and 14.64% used by Monsanto to calculate the ratio of driftable fines for the MON54140 and the MON54140+MON79789 mixes, respectively. By correcting the driftable fractions to match the driftable fines used in AgDRIFT results in greater no-effect distances. Further, the assumption of driftable ratio correction is not consistent for other DSD spectra (*e.g.*, very fine to fines). If the assumptions for coarser droplet spectra (*i.e.*, lower driftable fraction) were consistent across all spectra, the correction approach to the application rate in AgDRIFT for driftable fraction would be a reliable method; however, this is not the case. Therefore the Agency used the Coarse DSD analysis as a refinement to the standard AgDRIFT modeling to estimate no-effect distances.

At the first refinement level, the difference between the Monsanto estimate and the Agency estimate of no-effect distances resulting from drift at the 0.5 lb a.e./A rate is approximately 100 ft for non-listed (100 ft vs 200 ft) and 375 ft for listed species (100 ft vs 475 ft).

The body of evidence highlight the variability in the available data. Where the distances at the higher, more conservative, end may be overestimating distance off field to no-effect, and the distances at the lower end, less conservative, may be underestimating buffer distances. A realistic distance from the application site to where no effects are observed ranges from 100-175 ft. Based on the weight of evidence for the coarser droplet spectra, this distance is 125 ft.[§]

Again, it is important to note that product and nozzle specific drift curves based on empirical data that are incorporated into specific label use directions would better inform the spray drift risk assessment and would likely result in smaller buffer distances between the treated field and non-target organisms.

[§] Label language for the proposed Monsanto product includes application must use flat fan nozzles with "very-coarse to ultra-coarse" droplet distribution.

Vapor Analysis

Additional analyses were completed to determine the potential contribution that vapor phase drift would impact the terrestrial risk assessment. The analyses are based on the potential for a semi-volatile compound such as dicamba acid to volatilize from the treated site and drift off-field and redeposit in sensitive, non-target areas and cause an effect. Data were gathered for dicamba acid, dicamba DGA, and dicamba DMA (in the case of volatile flux data). This was done so that the Agency is able to provide multiple lines of evidence to support risk conclusions. Based on these multiple lines of evidence and characterization of the potential for off-field drift due to volatilized material, the Agency concluded that the dominant route of off-field exposure is more likely to be a result of spray drift and runoff based on the analysis below. However there are associated uncertainties regarding the amount of dicamba that volatilizes from a field treated with the dicamba DGA salt formulation. Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations. Without these data the Agency used a number of tools to estimate exposure and convert the vapor phase air concentration to a deposition value to calculate risk to sensitive non-target plants.

As part of the multiple lines of evidence approach, multiple screening-level tools (models and data) were used to characterize and support the Agency's conclusions. The screening tool used for characterization of non-target plant risk from volatile mass utilizes physical and chemical properties to predict flux based on the work by Woodrow *et al.* (1997) and a model developed by the Office of Solid waste and Emergency Response that estimates vapor phase exposure to non-target plants. Woodrow *et al.* (1997) and Woodrow *et al.* (2001) developed a linear regression between the natural logarithm of a chemical's physical and chemical properties to the natural logarithm of the amount of chemical emitted from the soil or foliar surface of a plant. However, like all linear relationships, half of the emissions were underestimated when compared to the measured values used to derive the relationship. For the purposes of characterizing volatile drift EFED used the data provided in the Woodrow papers to estimate the 90th percentile upper confidence limit around the slope and intercept so that 90% of the estimated flux rates would exceed the measured values, *i.e.*, a conservative estimate of flux. The estimated flux along with the AERSCREEN** model estimates of air concentrations at different distances from a treated field can be calculated, however EFED applied the air concentration to calculate an approximation of deposition in order to estimate what the air concentration would need to be at the edge of the treated field in order to cause an effect (see discussion below). The equation below is a modification of the Woodrow *et al.* (1997) equation based on a series of field trials for volatile and semi-volatile compounds used to estimate the flux from a field for foliar applied compounds.

Modified Woodrow equation for Plants:

$$flux = e^{(0.8268 \ln(VP) + 12.081)} \div 3600$$

Where:

** http://www.epa.gov/ttn/scram/dispersion_prefrec.htm

VP = vapor pressure in Pa

$flux$ = mass of vapor emitted from the field per unit area per second ($\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$)

$$flux = 0.566 \mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$$

In order to estimate the amount of mass potentially drifted as vapor from the field off-site, EFED adapted the Office of Solid waste and Emergency Response USEPA (2005) tool for estimating vapor phase exposure to non-target plants to develop an aerial vapor transfer concentration from the air concentration; termed Aboveground Product Concentration Due to Air-to-Plant Transfer (equation 5-18 of USEPA, 2005). Conceptually the plant concentration (deposition) is calculated from the aboveground produce concentration do to air-to-plant transfer (vapor transfer). The air-to-plant transfer was developed to determine the exposure of plants from point source contaminant release sites that were in the vapor phase. This equation was adapted, and used with the inhalation screening tool (AERSCREEN) to determine the air concentration at the edge of field.

$$P_v = Q \cdot F_v \cdot \frac{C_{yv} \cdot B_{vag} \cdot V_{Gag}}{\rho_a}$$

Where:

P_v = Concentration of compound of potential concern (COPC) in the plant resulting from air-to-plant transfer ($\mu\text{g COPC}/\text{g DW}$)^{††}

Q = COPC emission rate (g/s) (assumed to be 0.1833 g/s)^{††}

F_v = Fraction of COPC air concentration in vapor phase (unitless) (conservatively assume 1 meaning 100% of compound in vapor phase)

C_{yv} = Unitized yearly average air concentration from vapor phase ($\mu\text{g}\cdot\text{s}/\text{g}\cdot\text{m}^3$)

B_{vag} = COPC air-to-plant biotransfer factor (unitless)^{§§}

V_{Gag} = Empirical corrector factor for aboveground produce (assumed 1 for compounds with $\text{Log}_{\text{kow}} < 4$)

ρ_a = Density of air (g/m^3) = 1,200 g/m^3

The air concentration determined using AERSCREEN (C_{yv}) was used as an input to the OSWER model. The resulting deposition (P_v) was compared to the soybean EC_{25} , converted to air-to-plant DW concentrations assuming one ton of grass (dry weight) per acre using equations A-2-19 and A-2-20 (USEPA, 2005, appendix A). Based on this calculation the Agency concludes that the resulting deposition at the edge of field from volatile drift of dicamba is less than the EC_{25} . In order to exceed the EC_{25} at the edge of field (*i.e.*, the air concentration results in a deposition greater than 0.0005 lb a.i./A) the air concentration (C_{yv}) would have to be greater than 721 $\mu\text{g}/\text{m}^3$. These comparisons of the air concentration values calculated from the OSWER tool to the air concentration estimated from AERSCREEN^{***} show that with a calculated flux rate of 0.566 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$ using the modified Woodrow equation (see above) the maximum 1-hour average

^{††} For the purposes of a screening model, EC_{25} plant deposition is effectively converted to air-to-plant vapor dry weight concentration assuming one ton of grass (dry weight) per acre (USEPA, 2005; Appendix A, equations A-2-19 & A-2-20).

^{††} Converting calculated flux rate from modified Woodrow et al. equation for an 80 acre field.

^{§§} Based on correlation of Log_{kow} and HLC (A-2-20 of USEPA, 2005).

^{***} Assumptions of flux, application rate, ... etc

concentration from AERSCREEN at the edge of the field is 283 $\mu\text{g}/\text{m}^3$ less than the air concentration required to exceed the EC_{25} (as predicted by the OSWER tool) but within the same order of magnitude.

Similarly, the volatile flux data (Theoretical Profile Shape (TPS) method) submitted by Monsanto in March, 2013 (MRID 49022501) provided a 6 hour average flux rate of 0.0004 $\mu\text{g}/\text{m}^2\cdot\text{s}^{-1}$, greater than 4 orders of magnitude lower than the Woodrow et al estimated flux rate. The air concentration and resulting deposition rate is directly proportional to the flux rate. Therefore since there is uncertainty about what the actual flux rate is, this value can be used as a lower bound estimate of flux. Using the lower bound estimate of flux from the treated field would result in low exposure concern off-field due to volatile drift.

The last screening-level tool that was used to estimate off-field exposure from volatile drift is the AERSCREEN model using the AERMOD deposition algorithm. Similar to the AERSCREEN Tier I analysis above, the air concentration at the edge of the field is approximately 283 $\mu\text{g}/\text{m}^3$ however using the AERMOD deposition algorithm the distance off field where no effect would be observed would be 1500m (*i.e.*, the distance where the deposition value is less than the EC_{25}). These estimates are based on the estimated flux using the Woodrow *et al.* equation as the upper bound. The lower bound TPS flux value results in no exceedance of the EC_{25} at the edge of the field.

Uncertainties associated with converting air concentrations to a plant deposition would be greatly reduced by the submission of a terrestrial plant vapor phase toxicity end point that measures air exposure concentrations.

Based on this multiple lines of evidence approach, the primary route of off-field exposure is more likely to be a result of spray drift and runoff. However, there are uncertainties associated with the analysis that would better clarify the potential for vapor phase exposure to dicamba.

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Appendix A. Tabulated Estimates by Method for Distances to No-Effect

Study/Analyses	Method	# Swaths	DSD	Distance (ft) 0.5 lb ae/A (non-listed)	Distance (ft) 0.5 lb ae/A (listed)	Source	Comments
SDTF (Coarse)	90 th %	4	C	210	475	EPA	Standard EFED approach for drift modeling outside of default assumptions (4-20 swaths, 90 th %-tile distribution).
SDTF (Coarse)	50 th %	4	C	125	250	EPA	
SDTF (Coarse)	90 th %	1	C	85	175	EPA	
SDTF (Coarse)	50 th %	1	C	--	--	EPA	
Field + AgDRIFT	50 th %	4	VC/UC	100	100	Monsanto	Monsanto proposed approach in MRID 49022404
Field + AgDRIFT	90 th %	4	VC/UC	140	140	Monsanto	
Plant height (NOAEC)	--	--	VC/UC	90	90	Monsanto	Monsanto analysis included in MRID 48876001
AgDrift + PMRA EAD model	--	--	VC/UC	175	175	Monsanto	--
SDTF (Malathion only) VC	--	--	VC/UC	81	81	Monsanto	Note: the only subset of data that contained vc/coarse DSD. Log-Log transformation.
Field (Clarity)	--	3 (120 ft)	UC	62	62	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
Field (Engenia)	--	3 (120 ft)	XC	106	106	BASF/Monsanto	Field studies (provided in power point presentation – Dec. 17, 2013)
CLA data	Based on fit curves and ln-ln transformed supporting data	1	VC/Low boom	87	87	EPA	50 th %-tile
		1	VC/Low boom	92	92	EPA	90 th %-tile*
		4	VC/Low boom	230	230	EPA	90 th %-tile *
		1	C-VC/High Boom	116	116	EPA	90 th %-tile*
		4	C-VC/High Boom	210	210	EPA	90 th %-tile*
		20	C-VC/High Boom	375	375	EPA	90 th %-tile
			Ave. (all)	142.75	172.75		All DSD
			Ave.(coarse)	124.08	124.08		DSD>VC
			Ave. (xc)	107.71	107.71		DSD>XC

*Note: no difference in ln-ln vs curve fit estimates.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

PC Code: 128931
DP Barcode: D378444

MEMORANDUM

DATE: March 8, 2011

SUBJECT: Ecological Risk Assessment for Dicamba and its Degradate, 3,6-dichlorosalicylic acid (DCSA), for the Proposed New Use on Dicamba-Tolerant Soybean (MON 87708).

TO: Michael Walsh, Risk Manager Reviewer
Kathryn Montague, Risk Manager, RM 23
Registration Division (7505P)

FROM: Iwona L. Maher, Chemist, ERB6
Michael Wagman, Biologist, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh (GrIM) 3-8-11
Michael Wagman 3/8/11

THROUGH: Mark Corbin, Branch Chief, ERB6
Environmental Fate and Effects Division (7507P)

Michael Walsh 3-8-11

The Environmental Fate and Effects Division (EFED) has completed a review of the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The use of dicamba on soybeans was assessed by the Environmental Fate and Effects Division (EFED) in 2005 (USEPA, 2005, D317696). The primary difference between the proposed new use on soybeans and the previous soybean use assessed is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications; however, for the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Therefore, an abbreviated ecological risk assessment is provided. Details on the fate and transport properties and effects data for dicamba can be found in the attached assessments.

Based on the proposed maximum application rates, there is a potential for direct adverse effects

to listed and non-listed birds (acute exposure), listed and non-listed mammals (chronic exposure), listed vascular aquatic plants, and listed and non-listed terrestrial dicots from the proposed new use. This assessment uses new submitted information on the toxicity of diglycolamine salt of dicamba (DGA) to terrestrial plants. Although for monocots toxicity of the DGA salt formulation is decreased compared to TGAI dicamba acid, the vegetative vigor data indicate that toxicity in the DGA salt formulation is enhanced for dicots. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself. The study with TGAI dicamba acid did not use surfactants or adjuvants. Although levels of concern were not exceeded for listed and non-listed species of monocots, exceedances for monocots would occur if toxicity data for dicamba acid was used in place of the data for the DGA salt. Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data; therefore, since risk to these taxa cannot be precluded, it is assumed.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new use of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans) is not available for analysis in LOCATES. Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

The following studies are identified as data gaps for dicamba and should be required to address the uncertainties described in this assessment:

850.1400	Chronic freshwater fish toxicity (TGAI)
850.1300	Chronic freshwater invertebrate toxicity (TGAI)
850.1400	Chronic estuarine/marine fish toxicity (TGAI)
850.1350	Chronic estuarine/marine invertebrate toxicity(TGAI)
850.2200	Avian acute oral toxicity (with a passerine species)
850.4250	Terrestrial plant toxicity (Tier II vegetative vigor, with lettuce using TEP)
850.5400	Green algae toxicity (TGAI)

Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba (MRID 43288001). Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

Although the risks, based on standard risk assessment methods used by the Environmental Fate and Effects Division (EFED), are not expected to differ from the previous assessment done for dicamba use on soybeans (because the rates are similar to those already assessed), there is potential for other ecological concerns that would not normally be captured using our standard

risk assessment methods. These concerns are related to a potential increase in usage of dicamba products and the proposed changes in the timing of applications. In general, there is also a potential for increased susceptibility of late season plants to direct impact from off-site transport. Thus, unlike previous assessments of dicamba the risk conclusions in this assessment have increased uncertainty.

PROBLEM FORMULATION

Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Dicamba controls annual, biennial and perennial broadleaf weeds in crops and grasslands, and it is used to control brush and bracken in pastures. Dicamba is formulated primarily as a salt in an aqueous solution. Supported forms are: dicamba acid (29801), dicamba dimethylamine salt - DMA (29802), dicamba sodium salt (29806), dicamba diglycoamine salt - DGA (128931), dicamba isopropylamine salt (128944) and dicamba potassium salt (129043).

This assessment is for the new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba (DGA); PC code 128931)] for use on dicamba-tolerant soybeans (MON 87708). Dicamba is currently registered for use on soybeans at applications rates similar to those proposed for the new use. The primary difference between the proposed new use on soybeans and the one proposed here is the timing of the applications. The current registration for dicamba use on soybeans is limited to pre-emergence applications. For the proposed new use on dicamba-tolerant soybeans, dicamba could be applied pre-emergence and/or post-emergence. Additionally, the maximum current application rate for soybeans (single application and maximum yearly applications) is 2.0 lb acid equivalent (a.e.)/acre. For the proposed new use on dicamba-tolerant soybeans, the maximum single application rate is 1 lb a.e./acre and the maximum yearly application rate is 2.0 lb a.e./acre.

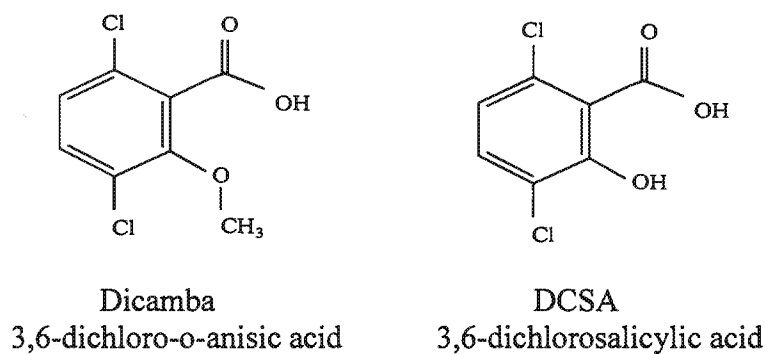
The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID 43245208). DCSA is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Toxicity data for DCSA and mammals have been submitted to the Agency. Based on available data, DCSA appears to be less toxic or equally toxic as the parent (see Table 1). Therefore, this assessment will consider the parent and its degradate DCSA (with the assumption that dicamba and DCSA are equatotoxic).

TABLE 1. Toxicity Data for the Dicamba Degradate DCSA (no registrant-submitted toxicity data are available for the degradate).

SOURCE	DICAMBA	DCSA
SUBMITTED DATA (Most Sensitive)		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	2,740	2,641 (MRID 47899504)
Chronic rat (NOAEC; mg/kg-bw)	45 (based on decreased pup weight at 136 mg a.e./kg-bw)	37 (based on decreased parental body weight) (MRID 47899517)
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	188	--
Acute Fish (LC ₅₀ ; mg/L)	28	--
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	34.6	--
Chronic FW Invertebrate (NOAEC; mg/L)	--	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	0.061	--
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	--
Acute Honeybees (LD ₅₀ ; µg/bee)	>90.65	--
PPDB (EU) WEBSITE¹		
Acute oral Rat (LD ₅₀ ; mg/kg-bw)	1,581	>1,560
Acute oral Avian (LD ₅₀ ; mg/kg-bw)	1,373	--
Acute Fish (LC ₅₀ ; mg/L)	>100	>100
Chronic Fish (NOAEC; mg/L)	--	--
Acute FW Invertebrate (EC ₅₀ ; mg/L)	>110.7	89
Chronic FW Invertebrate (NOAEC; mg/L)	97	--
NV Aquatic Plant (EC ₅₀ ; mg/L)	1.8	138
V Aquatic Plant (EC ₅₀ ; mg/L)	>3.25	>73
Acute Honeybees (LD ₅₀ ; µg/bee)	>100	--
Acute Earthworms (LC ₅₀ ; mg/kg)	>1,000	>1,000

1 Pesticide Properties Database (PPDB) (<http://sitem.herts.ac.uk/aeru/footprint/en/index.htm>)

Figure 1: Chemical Structures for Dicamba and its Degradate DCSA



BACKGROUND

The most recent regulatory actions for dicamba include the following:

- US EPA/EFED (2010) Reduced Risk Request for Dicamba Herbicide Over-The-Top of Dicamba-Tolerant Soybean. May 27, 2010.
- US EPA. (2010) EFED Response to a FIFRA Section 18 Emergency Exemption for Dicamba co-formulated with 2,4-D (Latigo™) Use on Teff grown for grain, seed, and hay to control broadleaf weeds. Requested by the Oregon Department of Agriculture. May 24, 2010. D377095
- US EPA (2006) Reregistration Eligibility Decision for Dicamba and Dicamba Salts. June 8, 2006.
- US EPA (2005) Drinking water assessment for dicamba on sugarcane. May 31, 2005. D317705
- US EPA (2005) EFED Reregistration Chapter for Dicamba/Dicamba Salts. August 31, 2005. D317696

Consistent with the previous assessments, the environmental fate and effects data used in this assessment will be bridged across the dicamba acid and all of the supported dicamba salts (MRID 43288001). EFED established a strategy for bridging the environmental fate and effects data requirements for the dicamba sodium and potassium salts, dimethylamine salt (DMA), isopropylamine salt and diglycoamine salt (DGA) to the dicamba acid. Bridging data were submitted indicating that the dicamba salts will be rapidly converted to the free acid of dicamba. Additionally, effects data provided indicate equitoxicity of the acid and salts (based on acid equivalents). EFED determined that fate studies conducted with dicamba acid provide "surrogate data" for the dicamba salts and that toxicity data across the acid and salts could generally be combined.

MODE OF ACTION

Dicamba is a benzoic acid herbicide similar in structure and mode of action to phenoxy herbicides. Like the phenoxy herbicides, dicamba mimics auxins, a type of plant hormone and causes abnormal cell growth by affecting cell division. Dicamba acts systemically in plants after it is absorbed through leaves and roots. It is easily transported throughout the plant and accumulates in new leaves.

USE CHARACTERIZATION

Monsanto Company submitted a new use request for the herbicide dicamba [M1691 Herbicide, EPA Reg. No. 524-582 (56.8% diglycolamine salt of dicamba)] for use on dicamba-tolerant soybeans (MON 87708). M1691 Herbicide is a water-soluble formulation intended for control and suppression of many broadleaf weeds, woody brush and vines. **Table 2** presents the

proposed application rates to the dicamba-tolerant soybean. Rates for dicamba salts are normalized to dicamba acid equivalent per acre (a.e./A).

Product Information

Product Name: M1691 Herbicide

Active Ingredient: Diglycolamine salt of dicamba (3,4-dichloro-o-anisic acid)*.....56.8%

Other Ingredients.....43.2%

Total.....100.0%

*Contains 38.5%, 3,6-dichloro-o-anisic acid (4 pounds acid equivalent per US gallon or 480 grams per liter).

TABLE 2. Dicamba DGA Proposed¹ Use Pattern for Dicamba-Tolerant Soybean.

Crop	Maximum Individual Application Rate ³ lbs dicamba a.e./A		Number of Applications	Minimum Application Interval (days)	Max Annual Application Rate in lbs dicamba a.e./A/year		Application Method
Dicamba-tolerant soybean MON 87708	Pre-emergence (pre-plant, at planting, or prior to crop emergence) ²	1.0	NS	Pre-plant, at planting or prior to crop emergence	1.0	2.0	Ground spray
	Post-emergence ¹ (Preharvest)	0.5	2 ⁴	From V3 (emergence) to before R1 (early flower) reproductive stage of soybean	1.0		
¹ - M1691 Herbicide ² - Registered uses ³ - "Acid equivalent" ⁴ - Calculated by dividing the max application rate by the max individual application rate.							

Proposed preharvest interval for soybean forage and hay are 7 and 14 days, respectively. The herbicide can be tank mixed with other products. According to the proposed label, aerial applications of dicamba to dicamba-tolerant soybeans is not allowed (*i.e.*, it is limited to ground applications).

Currently, BASF maintains registration for dicamba as the dimethylamine (DMA), diglycolamine (DGA), isopropylamine (IPA), sodium (NA) and potassium (K) salts. To date dicamba salts have registered uses on right-of-way areas, asparagus, barley, corn, grasses grown in pasture and regland, oats, proso millet, rye, sorghum, soybeans (preemergent), sugarcane, wheat, and uses on golf courses and residential lawns. Chemical structures of dicamba salts are provided in Table 1, Attachment I.

The proposed dicamba registration is for use on dicamba-tolerant soybean (MON 87708). Dicamba-tolerant soybeans (MON 87708) are not currently available for sale in the United States, therefore, maps of specific use-sites are not available. However, maps for soybean acreage can be used as a proxy under the assumption that dicamba-tolerant soybeans could be grown wherever soybeans are grown. Based on National Agricultural Statistics Service (NASS) 2009 data, soybeans are grown primarily in the central portions of the United States (see Fig. 2). These represent potential use sites for use of dicamba on dicamba-tolerant soybeans.

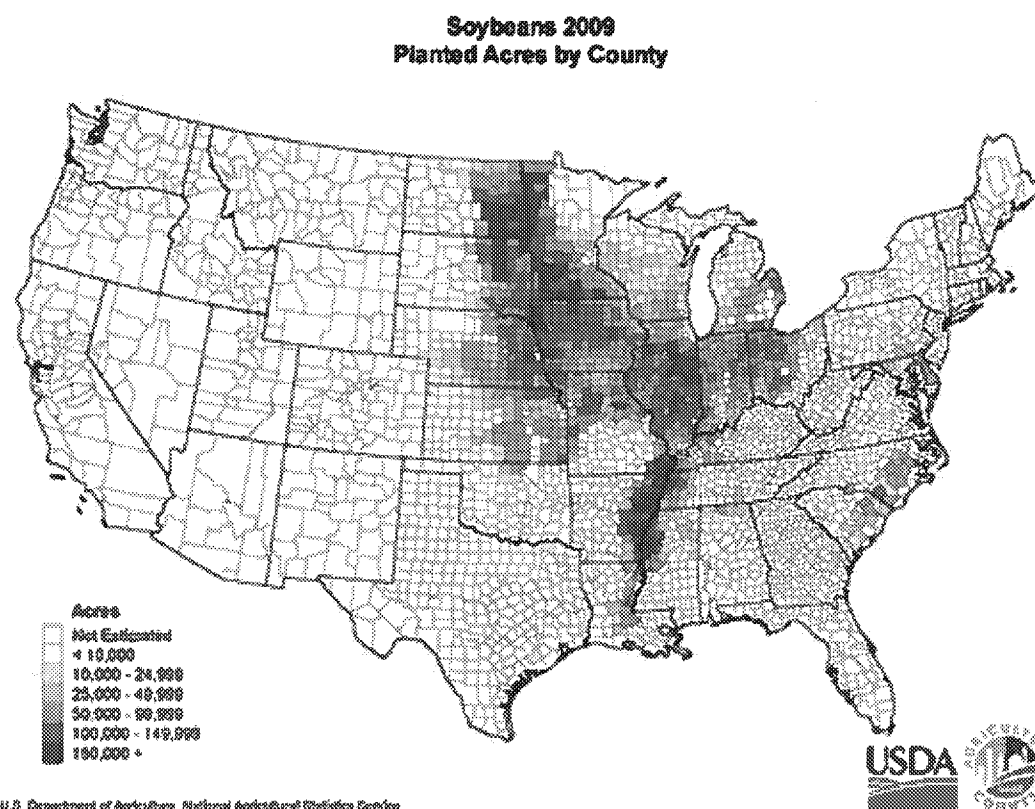


FIGURE 2. Acres of Soybeans Grown By County in the United States in 2009 (based on information from USDA-NASS)
(http://www.nass.usda.gov/Charts_and_Maps/Crops_County/sb-pl.asp).

ENVIRONMENTAL FATE CHARACTERISTIC

Dicamba is a benzoic acid herbicide applied to leaves or to soil as a growth regulator, and is absorbed by leaves and roots moving throughout the plant. In some plants, it may accumulate in the tips of leaves. Some plants can metabolize or break down dicamba.

Dicamba is very soluble (6,100 ppm) and very mobile ($K_{oc} = 13.4$) in the laboratory, and is not expected to bioaccumulate in aquatic organisms because it is an anion at environmental pHs ($pK_a = 1.9$). The active ingredient can reach surface water via run-off, spray drift during application, and vapor drift/volatilization. Multiple literature studies show that there is a high vapor drift from soybean fields resulting in non-target plant injury¹. Since dicamba is not persistent under aerobic conditions, very little dicamba is expected to leach to groundwater. In two acceptable field dissipation studies conducted with dimethylamine salt of dicamba, dicamba was found in soil segments deeper than 10 cm (half-life range = 4.4 to 19.8 days, MRID 43651405, MRID 43651407). Any dicamba reaching anaerobic ground water would be

¹ Al-Khatib and Tamhane, 1999; Auch and Arnold, 1978; Everitt and Keeling, 2009; Kelley et al., 2005; Hamilton and Arle, 1979; Lanini, 2000; Marple et al., 2008; Wall, 1994; Weidenhamer et al., 1989; Wax et al., 1969.

somewhat persistent (due to its anaerobic half-life of 141 days).

Aerobic soil metabolism is the main degradative process for dicamba (6 days, MRID 43245207). Dicamba is stable to abiotic hydrolysis at all pH's and photodegrades slowly in water and on soil and is more persistent under anaerobic conditions in soil:water systems in the laboratory (141 days, MRID 43245208). A supplemental aerobic aquatic metabolism study of dicamba indicates that dicamba degrades more rapidly in aquatic systems when sediment is present. Its aerobic soil metabolism half-life in sediment:water system is about 24 days.

The major degradate under anaerobic conditions is 3,6-dichlorosalicylic acid (DCSA) which is persistent, comprising > 60% of the applied after 365 days of anaerobic incubation in sediment:pond water system (Stable, MRID# 43245208). DCSA is non-persistent when formed under aerobic conditions and degrades roughly at the same rate as the parent (8.2 days, MRID 43245207). DCSA was also found in the two acceptable field studies in soil segments deeper than 10 cm, and is believed to be persistent if it was to reach anaerobic ground water. The degradate is formed in aerobic soil under laboratory conditions at the maximum of 17.4 % of the applied parent. Other minor dicamba degradates of concern are DCGA and 5-OH-dicamba, and both are less toxic than the parent and DCSA. The formation of DCGA in the laboratory studies did not exceed 3.64%, and the formation of 5-OH dicamba did not exceed 1.9 % in soil/water system during anaerobic aquatic degradation of dicamba under laboratory condition.

Dicamba nomenclature including selected physical-chemical and fate properties for dicamba are provided below in Table 3. Chemical structures of dicamba and dicamba salts are presented in Table 1, Attachment I. The maximum percent formations of dicamba's metabolites are provided in Table 2, Appendix I. Further details regarding fate and transport laboratory and field studies submitted for dicamba can be found in the EFED Reregistration Chapter (US EPA, 2005).

TABLE 3. Selected Physical-Chemical and Fate Properties of Dicamba Acid.

CAS Name	3,6-dichloro-2-methoxybenzoic acid
IUPAC Name	3,6-dichloro-o-anisic acid
CAS No	1918-00-9
PC Code	029801
Empirical Formula	C ₈ H ₆ Cl ₂ O ₃
Molecular Weight	221.04
Common Name	Dicamba
Formulated Product	Banex; Banlen; Banval; Banvel; Banvel 10G; Banvel 4E; Banvel 5G; Banvel CST; Banvel D; Banvel XG; dianat; Dicambe; Dicamba; Dicamba ; dicamba + 2,4-D; dicamba + atrazine; dicamba (amine); Clarity; Marksman; MDBA; Mediben; Velsicol 58-CS-11; Velsicol compound "R"
Pesticide Type	Herbicide
Chemical Family	Benzoic acid
Color/Form	Colorless crystals
Odor	Odorless
Melting Point	114 - 116°C (Kidd and James, 1991))

Flash Point	199°C (Gosselin, 1984)
Relative Density	1.57 g/ml at 25°C (Spectrum Laboratories: Chemical Fact Sheet)
Water Solubility	6100 mg/L SANDOZE Safety Data Sheet (Nov, 1989) 8240 mg/L at 25°C (Toxicology and Regulatory Affairs Flemington, NJ) 6500 mg/L at 25°C (Kidd and James, 1991)
Solubility in other solvents	Acetone 810 g/L at 25°C Dichloromethane 260 g/L at 25°C Dioxane 1.18 kg/L at 25°C Ethanol 922 g/L at 25°C Toluene 130 g/L at 25°C Xylene 8 g/L at 25°C (Worthing 1987)
Vapor Pressure	3.41 E-05 torr (25°C) SANDOZE Safety Data Sheet (Nov, 1989) 3.4 E-05 torr (25°C) (Kidd and James, 1991))
Henry's Law Constant	1.79 E-08 (ARS Pesticide Properties Database)
pKa	1.87 (MRID 43288001)
K _d (Freundlich) K _{oc}	0.07 - 0.53 mL/g (MRID 42774101) 3.45 - 21.1 mL/g (MRID 42774101)

Aquatic Exposure Estimates

The Tier II modeling was performed for dicamba acid and its major degradate DCSA using PRZM (v3.12.2; May 12, 2005)/EXAMS (v. 2.98.04.06; April 25, 2005) coupled with the standard pond scenario. Standard Mississippi soybean scenario was selected to assess runoff potential from vulnerable use sites. The modeling scenario for DCSA was based on the following: (1) assuming 17.4% conversion from parent DCSA and (2) using molecular weight conversion to adjust from parent application rate to DCSA application rate. **Tables 4 and 5** list the input parameters used for the PRZM/EXAMS modeling of dicamba acid and DCSA degradate.

TABLE 4. PRZM/EXAMS Input Parameters for Dicamba.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 1.12; 0.56; 0.56	M1691; EPA Reg. No. 524-582
Number of appl./season	Soybean: 3	M1691; EPA Reg. No. 524-582
Interval between appl. (d)	3 days	M1691; EPA Reg. No. 524-582
Application Method	Soybean: Ground	M1691; EPA Reg. No. 524-582
Scenario modeled (Metfile) - Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	221	SANDOZE Safety Data Sheet (Nov, 1989).
Solubility @ 25°C (mg/L)	6100	SANDOZE Safety Data Sheet (Nov, 1989).
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	SANDOZE Safety Data Sheet (Nov, 1989).

K _{oc} (mL/g)	13.4 (average)	MRID 42774101; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	18	MRID 43245207; (6d x 3) input parameters guidance (10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 5905-564
Spray Drift Fraction	0.01 ground	Input guidance, 2009
Application Efficiency	0.99 ground	Input guidance, 2009
Aerobic Aquatic Metabolic Half-life (days)	72.9	MRID 43758509; 3x a single half-life value of 24.3 days was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	423	A single half-life value was available (MRID 43245208); 3x the half-life value (141 x 3 = 423) was used per Input Parameter Guidance 2009.
Hydrolysis (pH 7) half-life (days)	0	Stable. MRID 40547902
Aquatic Photolysis Half-life (days)	105	MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight. Degradate not present.

Table 5. PRZM/EXAMS Input Parameters for DCSA.

Model Input Variable	Input Value	Source and Comments
Application rate (kg ai/hectare)	Soybean: 0.18; 0.09; and 0.09	(degradate molecular weight)/(parent molecular weight) x max%formation x application rate = (207/221)x 0.174 x 1.12
Number of appl./season	Soybean: 3	EPA Reg. No. 524-582
Interval between appl. (d)	3 days	EPA Reg. No. 524-582
Scenario modeled (Metfile) -Initial Application Date	MSsoybeanSTD (W03940.dvf) - 16 April	Dates based on the crop profile, date of planting, & precipitation data.
Henry's Law Constant (atm m ³ /mol)	1.6 x 10 ⁻⁹	Estimated for dicamba and used for DCSA (VP x MW)/(760 torr/1 atm * solubility)
Molecular Weight (g/mol)	207	Product Chemistry
Solubility @ 25°C (mg/L)	2112	MRID 43095301
Vapor Pressure (torr)	3.41 x 10 ⁻⁵	For Dicamba. SANDOZE Safety Data Sheet (Nov, 1989).
K _{oc} (mL/g)	1208 (average)	MRID 43095301; Input parameters guidance (10/22/2009).
Aerobic Soil Metabolic Half-life (days)	24.6	MRID 43245207; (8.2 d x 3) (Input Parameters Guidance; 10/22/2009).
Is the pesticide wetted-in?	No	EPA Reg. No. 524-582
CAM	1	DCSA formed from parent in the top soil layer
Spray Drift Fraction	0	Assumed formed in the soil
Application Efficiency	1.0	Assumed formed in the soil
Aerobic Aquatic	49.2	No acceptable data were available; 2x the half-life corresponding to the PRZM aerobic soil metabolism rate

Metabolic Half-life (days)		input value (2x 24.6d) was used per guidance (Input guidance, 2009).
Anaerobic Aquatic Metabolic Half-life (days)	0	Stable. MRID 43245208. Input Parameter Guidance 2009.
Hydrolysis (pH 7) Half-life (days)	0	Stable. MRID# 43245208
Aquatic Photolysis Half-life (days)	105	No data for DCSA; therefore, used value for dicamba: MRID 42774102. Input Parameter Guidance 2009. Adjusted half-life to represent sun intensity and 12 hours of sunlight per day. 38.1 day value represented continuous sun exposure at an intensity of 1.38 times natural sunlight.

PRZM-EXAMS Modeling Output

Table 6 presents combined PRZM/EXAMS estimated environmental concentrations in surface water for dicamba acid and the DCSA degradate for the proposed use on dicamba-tolerant soybean. These estimated environmental concentrations (EECs) were used to calculate risk to aquatic animals and plants.

The 1-in-10-year peak concentration for dicamba acid for modeled soybean scenario is 38 µg/L, the 21-day average concentration is 36 µg/L, and the 60-day average concentration is 31 µg/L. Table 6 provides combined EECs for dicamba parent and DCSA degradate. The PRZM/EXAMS output files are provided in the **APPENDIX II**.

TABLE 6. Combined PRZM/EXAMS Estimated Environmental Concentrations (EECs) for Dicamba Acid and DCSA Degradate.

Scenario	Estimated Water Concentrations (µg/L)		
	1-in-10-year Peak EEC	1-in-10-year 21-day mean EEC	1-in-10-year 60-day mean EEC
Dicamba and DCSA¹			
MS Soybean – water column	40.3	37.9	33.1

¹ The EEC presents a combined value for the parent and degradate

ASSUMPTIONS AND UNCERTAINTIES

The following uncertainties have been identified in the environmental fate properties and aquatic assessment for dicamba and its degradate DCSA:

- The proposed label does not specify the minimum application interval between the consecutive applications, but the approximate growth stage of the plant. Therefore, for this assessment, it was assumed that the minimum application interval between the consecutive applications is 3 days.
- DCSA percent formation used for the modeling “application rate” calculation was based on the amount of degradate formed in the aerobic soil metabolism conducted on silt loam soil. It

is possible that DCSA maybe formed in different amounts in different soil types, and result in DCSA EECs being underestimated. The use of 100% conversion from the parent to DCSA, however, was not pursued herein as this approach would be overly conservative.

- The PRZM/EXAMS aerobic aquatic metabolism input parameter is based on a supplemental study, although there are uncertainties associated with the aerobic aquatic metabolism half-life (MRID 43758509), the input parameter is more conservative than the one previously used in the aquatic assessments (US EPA, 2010).

MONITORING DATA

Surface water and groundwater monitoring data from the United States Geological Survey (USGS) NAWQA program was accessed on November 16, 2010 and all filtered water data (.7 micron glass fiber filter) were downloaded. A total of 14163 water samples from 6243 sites were analyzed for dicamba. Of these samples, 268 (3.4%) out of 7822 samples had positive detections of dicamba in surface water, and five out of 6341 samples in groundwater. The maximum concentration detected in filtered water from surface water was 1.76 µg/L in the Rocky Creek at State Hwy 587 at Citrus Park, Hillsborough County, Florida. Dicamba was detected in the Zollner Creek near Mt Angel, Oregon (agricultural area), in 19 samples with concentrations ranging 0.0097 -0.3775 µg/L and in the White Rock Creek at Greenville Ave, Dallas, Texas (urban area), in 16 samples with concentrations ranging from 0.0113 -0.3175 µg/L. The maximum estimated concentration detected in the filter groundwater was 4.03 µg/L in urban area (SH:UR-18) in Shelby, Tennessee. Overall the filtered surface water samples were detected at various areas with concentrations ranging 0.0094 -1.76µg/L, while groundwater filtered samples with concentration ranging 4.03 (estimated value)-0.14 µg/L. No clear pattern in dicamba detections from different use sites is evident because dicamba was detected in a number of different types of watersheds (agricultural, urban, mixed and other) as classified by the USGS land use information. Most of this data is non-targeted (*i.e.*, study was not specifically designed to capture dicamba concentrations in high use areas). Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. This coupled with the fact that these data are not temporally or spatially correlated with dicamba application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment.

Monitoring data are available in the Pesticides in Ground Water Database [Hoheisel *et al.* 1991] for dicamba (3,172 wells sampled) and 5-hydroxy dicamba (87 wells sampled). Out of the wells sampled, there were no reports of residues greater than the stated MCL (200 µg/L lifetime). However, the detection limits are unknown, and it is not known if wells were sampled in areas where dicamba was used. STORET contains records for sampling for dicamba in samples from lakes, ocean, estuary, canal, or reservoir sites. The data have not been extensively evaluated; in addition, it is uncertain what the actual detection limits were for the samples and whether samples were taken from areas where dicamba was not in use.

ENVIRONMENTAL EFFECTS DATA

Assessment of risk is based on the most sensitive species tested for terrestrial and aquatic

organisms. The acute and chronic toxicity values for the most sensitive terrestrial and aquatic organisms tested are presented in Table 7. These endpoints are based on those presented in the most recent assessment conducted for dicamba, except for the terrestrial plant endpoints (USEPA 2010, D029801). The risks to terrestrial plants were evaluated using new toxicity information from a seedling emergence (MRID 47815101) and vegetative vigor (MRID 47815102) terrestrial plant studies conducted with a typical end-use product (TEP) representative of the product being proposed here for use on dicamba-tolerant soybean. The new vegetative vigor study was determined to be supplemental due to a decrease in plant height in lettuce controls. Quantitative data for the other nine species in the study may be used in risk assessment, but the endpoints for lettuce may not be used in risk assessment. The new data indicates that the DGA salt may be less toxic to monocots, but has an EC₂₅ approximately 13 times more toxic to the vegetative vigor of dicots than dicamba acid. It is unclear if the enhanced toxicity to dicots is due to synergistic effects with surfactants and adjuvants in the formulation used (Clarity Herbicide, EPA Reg No. 7969-137, 56.8% DGA salt) or due to the DGA salt itself.

TABLE 7. Toxicity Values Used to Assess Risks from Use of Dicamba.

SPECIES	ACUTE ENDPOINT	NOAEC	MRID
Rainbow trout (<i>Oncorhynchus mykiss</i>)	LC ₅₀ = 28 mg a.e./L	No data available	40098001 ¹
Sheepshead minnow (<i>Cyprinodon variegatus</i>)	LC ₅₀ > 180 mg a.e./L	No data available	000253901
Water flea (<i>Daphnia magna</i>)	EC ₅₀ > 100 mg a.e./L	No data available	40094602
Grass shrimp (<i>Palaemonetes pugio</i>)	EC ₅₀ > 100 mg a.e./L	No data available	00034702
Duckweed (<i>Lemna gibba</i>)	IC ₅₀ > 3.25 mg a.e./L	NOAEC = 0.20 mg a.e./L	42774111
Blue-green algae (<i>Anabaena flos-aquae</i>)	IC ₅₀ = 0.061 mg a.e./L	NOAEC = 0.005 mg a.e./L	42774109
Bobwhite quail (<i>Colinus virginianus</i>) or Mallard duck (<i>Anas platyrhynchos</i>)	LD ₅₀ = 188 mg a.e./kg-bw (quail) LC ₅₀ > 10,000 mg a.e./kg-diet (quail)	NOAEC = 800 mg a.e./kg-diet (duck) (based on a reduction in hatchability at 1,600 mg a.e./kg-diet)	42918001, 00025391, 43814003
Rat (<i>Rattus norvegicus</i>)	LD ₅₀ = 2,740 mg a.e./kg-bw	NOAEL = 45 mg a.e./kg-bw (based on decreased pup weight at 136 mg a.e./kg-bw)	00078444, 43137101
Honey bee (<i>Apis mellifera</i>)	LD ₅₀ > 91 µg a.e./bee	No data available	00036935
Dicot (Tomato, <i>Lycopersicon esculentum</i>) – seedling emergence	EC ₂₅ = 0.123 lbs ae/A	NOAEC = 0.0673 lbs ae/A	47815101
Monocot (Onion, <i>Allium cepa</i>) – Seedling Emergence	EC ₂₅ = 1.68 lbs ae/A	NOAEC = 0.64 lbs ae/A	47815101
Dicot (Soybean, <i>Glycine max</i>) – Vegetative Vigor	EC ₂₅ = 0.000513 lbs ae/A	EC ₀₅ = 0.000013 lbs ae/A	47815102 ²
Monocot (Onion, <i>Allium cepa</i>) – Vegetative Vigor	EC ₂₅ = 0.472 lbs ae/A	EC ₀₅ = 0.137 lbs ae/A	47815102 ²

¹ The raw data from this study (Mayer and Ellersieck, 1986; MRID 40098001) were not available for review.

Therefore, per current EFED policy regarding the results from this study, the study was classified as ‘supplemental’.

² Currently in review.

“a.e.” = acid equivalent.

RISK ESTIMATION & CHARACTERIZATION

Aquatic Organisms

The only acute RQ that could be calculated for aquatic animals based on available data is for freshwater fish [specifically rainbow trout (*Oncorhynchus mykiss*) (MRID 40098001)]. The acute RQ for freshwater fish is <0.01 for both dicamba (37.9 µg a.e./L divided by 28,000 µg a.e./L) and DCSA (2.4 µg a.e./L divided by 28,000 µg a.e./L). The results from the remaining acute aquatic animal studies are from limit tests and are non-definitive (*i.e.*, the LC₅₀/EC₅₀'s are 'greater than' values); therefore, acute RQs cannot be calculated using these data.

In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic animals, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentrations tested in the acute aquatic animal studies represent endpoints (*e.g.*, acute: LC₅₀ = 100 mg a.e./L). In this exercise, none of the acute RQs for estuarine/marine fish or aquatic invertebrates (freshwater and estuarine/marine) would exceed an Agency level of concern (LOC) for dicamba or DCSA (they are all <0.01).

Risks to aquatic animals from chronic exposure to dicamba could not be assessed at this time because of a lack of data. Since risk cannot be precluded, it is assumed.

For aquatic plants the only RQ that exceeds an Agency LOC is for listed non-vascular aquatic plants and dicamba (RQ = 7.6) (see **Table 8**). The results from the available vascular aquatic plant study are non-definitive (*i.e.*, the IC₅₀' is a 'greater than' value); therefore, a non-listed species RQ cannot be calculated using these data. In order to gain a better understanding of how the EECs for the maximum proposed dicamba application rate for soybeans relate to the toxicity data currently available for aquatic vascular plants, we compared the EECs to the toxicity endpoints using the conservative assumption that the highest concentration tested in the vascular aquatic plant study represents the endpoint (*i.e.*, IC₅₀ = 3.25 mg a.e./L). In this exercise, the RQ would not exceed the Agency's level of concern (LOC) for dicamba or DCSA (they are <0.01).

TABLE 8. RQs for Aquatic Plants and the Use of Dicamba on Soybeans.

TAXON	LISTED/NON-LISTED	ENDPOINT (µg a.e./L)	MS -SOYBEANS			
			DICAMBA		DCSA	
			EEC (µg a.e./L)	RQ	EEC (µg a.e./L)	RQ
Vascular Aquatic Plant	Non-listed species	Non-definitive	37.9 (peak)	N/A	2.4 (peak)	N/A
	Listed species	NOAEC = 200	37.9 (peak)	0.2	2.4 (peak)	0.01
Non-Vascular Aquatic Plant	Non-listed species	IC ₅₀ = 61	37.9 (peak)	0.6	2.4 (peak)	0.04
	Listed species	NOAEC = 5	37.9 (peak)	7.6	2.4 (peak)	0.5

Bolded numbers exceed the Agency LOC of '1'.

"a.e." = acid equivalent.

"N/A" = not applicable

Terrestrial Organisms

In the EFED Reregistration Chapter for Dicamba/Dicamba Salts (USEPA 2005; DP 317696), the maximum single application rate assessed was 2.0 lb a.e./acre. The maximum single application rate for the proposed new use of dicamba on dicamba-tolerant soybeans is 1.0 lb a.e./acre, with a maximum yearly application rate of 2.0 lb a.e./acre. The maximum single application rate of 1.0 lb a.e./acre can only be used once; the maximum application rate for subsequent applications is limited to 0.5 lb a.e./acre. T-REX does not currently model RQs for multiple applications that have different single application rates (*i.e.*, when entering the application rate for multiple applications into the model, the application rates must be the same for the RQs to be automatically calculated).

In the previous assessments conducted by EFED (USEPA, 2005, 2010), there were risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) identified based on LOC exceedences from RQs calculated in T-REX using the 2.0 lb a.e./acre application rate. We re-ran T-REX using the 1.0 lb a.e./acre application rate. At the 1.0 lb a.e./acre application rate, the Agency's acute LOCs are exceeded for listed and non-listed birds [acute dose-based RQs range from <0.01 (1,000 g bird that eats seeds) to 2.0 (20 g bird that eats short grass)] (see Table 9 and APPENDIX IV). No chronic RQs exceed the Agency's LOC for chronic risk (chronic dietary-based RQs range from 0.02 to 0.30).

TABLE 9. Acute Dose-Based RQs for Birds from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based EEC/adjusted LD50)	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	2.02	0.90	0.29
Tall Grass	0.92	0.41	0.13
Broadleaf plants/sm insects	1.14	0.51	0.16
Fruits/pods/seeds/lg insects	0.13	0.06	0.02
Seeds (granivore)	0.03	0.01	0.00

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's acute risk LOC for non-listed species (RQ > 0.5) and/or the acute risk LOC for listed species (RQ > 0.1).

For mammals, none of the acute RQs exceed any of the Agency's LOCs (acute dose-based RQs range from <0.01 to 0.04). Additionally, none of the dietary-based chronic RQs exceed the Agency's LOCs for chronic risk (chronic dietary-based RQs range from 0.02 to 0.27). Chronic dose-based RQs, however, do exceed the Agency's LOC for chronic risk (chronic dose-based RQs range from 0.01 to 2.3) (see Table 10 and APPENDIX IV).

TABLE 10. Chronic Dose-Based RQs for Mammals from T-REX for Dicamba Use on Dicamba-Tolerant Soybeans¹.

Dose-based RQs (Dose-based NOAEL)	Small mammal 15 grams	Medium mammal 35 grams	Large mammal 1000 grams
Short Grass	2.31	1.98	1.06
Tall Grass	1.06	0.91	0.49

Broadleaf plants/sm insects	1.30	1.11	0.60
Fruits/pods/lg insects	0.14	0.12	0.07
Seeds (granivore)	0.03	0.03	0.01

¹ One application at 1.0 lb a.e./acre was modeled

Bolded numbers exceed the Agency's chronic risk LOC for listed and non-listed species (RQ > 1).

Therefore, there are still risks to birds (acute - listed and non-listed) and mammals (acute – listed; chronic – listed and non-listed) with the single maximum application rate of 1.0 lb a.e./acre.

Based on the available acute toxicity data available for honey bees, dicamba is classified as practically non-toxic to beneficial terrestrial invertebrates.

Terrestrial Plants

Dicamba exposure to terrestrial and semi-aquatic plants is estimated using the TerrPlant (version 1.2.2) model. The model generates EECs for plants residing near a use area that may be exposed via runoff and/or spray drift. The EECs are generated from one application at the maximum rate for a particular use and compound-specific solubility information. Only a single application is considered because it is assumed that for plants, toxic effects are likely to manifest shortly after the initial exposure and that subsequent exposures do not contribute to the response. Hence, the model estimates EECs based on application rate, the solubility factor, and default assumptions of drift. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method and can be found in Appendix V.

The EECs and resulting RQs for terrestrial and semi-aquatic plants for a single application of dicamba DGA at the maximum label rate for the proposed use on dicamba-tolerant soybeans are presented in **Tables 11 and 12**. RQs were exceeded for listed and non-listed dicots due to spray drift or in semi-aquatic areas due to runoff and spray drift.

Table 11. EECs for Terrestrial and Semi-Aquatic Plants Near Dicamba Use on Dicamba-Tolerant Soybeans.

Crop	Single Max. Application Rate (lbs a.e./A)	EECs (lbs a.e./A)		
		Total Loading to Adjacent Dry Areas (sheet runoff + drift)	Total Loading to Semi-Aquatic Areas (Channelized runoff + drift)	Drift EEC
Dicamba-Tolerant Soybeans	1.0	0.06	0.51	0.01

Table 12. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine Salt (DGA) through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1

Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23
*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.				

EFED's current screening tool TerrPlant results in a RQ of 0.89 for listed species and 0.49 for non-listed species of dicots in dry areas, which is less than the LOC for plants of 1.0. However, using AgDrift, with standard default assumptions, the RQ exceeds the listed species LOC at ≤ 142 feet from the application site. At 100' from the application area, the RQ=1.45 and at 50' from the application area the RQ=2.54. Similarly, using AgDrift, the RQ for non-listed species exceeds the LOC at ≤ 77 feet from the application site. For ground application in dry areas, listed dicot populations must be > 142 feet from the application area to be protected and non-listed dicot populations must be > 77 feet from the application area to be protected. **Table 13** shows the distance from the edge of field (as calculated by AgDrift) where the RQ falls below the risk to terrestrial plant LOCs. Listed plant species that may be similar to tomatoes or soybeans would exceed the LOC even if a 1000' buffer was applied to the application site. These calculations used a default droplet size distribution of fine to medium. Different droplet spectra (e.g. coarser drop size distributions) would yield less spray drift and lower RQs.

The aforementioned RQ values are for the DGA salt of dicamba. For dicamba acid, which DGA salt may dissociate to and which has more sensitive seedling emergence values, RQ values would exceed the LOC of 1.0 for all listed and non-listed monocots and dicots in semi-aquatic areas and for listed monocots and listed and non-listed dicots in dry areas. It is unclear what the differences in observed toxicities of the seedling emergence and vegetative vigor studies between the DGA salt and dicamba acid is due to.

Table 13 Distance (feet) from the edge of field where the RQ falls below the risk to terrestrial plant LOC for seedling emergence and vegetative vigor endpoints for ground application, based on AgDRIFT EECs.

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Corn	30	<3.3	<3.3	<3.3
Ryegrass	<3.3	<3.3	<3.3	<3.3
Wheat	<3.3	<3.3	3.3	<3.3
Onion	<3.3	<3.3	7	<3.3
Oilseed rape	233	<3.3	10	<3.3
Soybean	10	3.3	>997	784
Cabbage	<3.3	<3.3	30	<3.3
Carrot	3.3	<3.3	171	13

Plant Species	Seedling Emergence		Vegetative vigor	
	Listed	Nonlisted	Listed	Nonlisted
Lettuce	3.3	<3.3	259	36
Tomato	10	7	>997	538

Incident Data

A preliminary review on February 23, 2011, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 2 reported ecological incidents associated with the use of DGA salt. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to DGA salt will not be included in this ecological risk assessment.

In 1998, in Lyon County, Minnesota, 120 acres of soybeans were adversely affected after dicamba DGA and clopyralid were applied. The type of injury was not reported. The incident was classified as probable for both dicamba DGA salt and clopyralid and the incident was considered as an accidental misuse. In 2007, in Imperial County, California, a complaint was received that alfalfa fields were damaged, with dead and stunted plants, and leaves curled and cupped. An application of dicamba DGA salt and 2,4-D DMA salt by air to adjacent fields was conducted, however, samples taken from the affected field were found negative for both dicamba and 2,4-D. This incident was classified possible for Dicamba DGA salt and 2,4-D DMA salt and was considered a registered use.

A review was also briefly conducted on the incident data for dicamba acid. The 2006 RED recorded thirty-five ecological incidents attributed to dicamba acid use having been recorded in the Ecological Incident Information System (EIIS) as of June 1, 2005. Since the RED, two additional incidents have been reported. In 2006, in St. Landry County, LA, 1500 acres of soybean were damaged by a combination of glyphosate, dicamba and 2,4-D. The type of injury was not reported. This incident was classified as probable for dicamba and 2,4-D and possible for glyphosate and the incident was considered as an intentional misuse. In 2007, in Lancaster County, PA, 4 rabbits were killed after a homeowner applied product with MCPP, Dicamba, and 2-4 D ingredients to the house lawn. This incident was classified as possible for all three active ingredients and the legality was undetermined. The earlier incidents reported include terrestrial, plant, and aquatic impacts. 19 of the incidents involve 2,4-D in addition to dicamba and sometimes other active ingredients. Although the database lists a terrestrial mammalian incident in Utah where dicamba was applied, the database states that dicamba is "unlikely" to have caused the incident. Impacts to plants included a wide range of crops (soybeans, corn, wheat) as well as non-agricultural applications. The specific impacts varied from browning and plant damage to mortality of all plants within the treated area. Aquatic impacts consist of two fish kill incidents associated with agricultural and residential turf application.

FEDERALLY-LISTED SPECIES

Potential effects to federally-listed endangered and threatened species (listed species) based on LOC exceedances require an in-depth listed species evaluation. Identified potential risks to listed species are summarized in **Table 14**.

TABLE 14. Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Dicamba on Dicamba-Tolerant Soybeans.

LISTED TAXON	DIRECT EFFECTS	INDIRECT EFFECTS
Terrestrial and semi-aquatic plants – monocots	No ¹	Yes ³
Terrestrial and semi-aquatic plants - dicots	Yes	Yes ³
Insects	No	Yes ³
Birds	Yes (Acute)	Yes ³
Terrestrial phase amphibians	Yes (Acute)	Yes ³
Reptiles	Yes (Acute)	Yes ³
Mammals	Yes (Chronic)	Yes ³
Aquatic plants	Yes (Non-vascular)	Yes ³
Freshwater fish	Yes (Chronic) ²	Yes ³
Aquatic phase amphibians	Yes (Chronic) ²	Yes ³
Freshwater crustaceans	Yes (Chronic) ²	Yes ³
Mollusks	No	Yes ³
Marine/estuarine fish	Yes (Chronic) ²	Yes ³
Marine/estuarine crustaceans	Yes (Chronic) ²	Yes ³

¹Listed species of monocots RQ values did not indicate risk from DGA salt, but risk was indicated for dicamba acid. DGA salt rapidly disassociates into dicamba acid.

²Risks could not be precluded due to a lack of data; therefore, risk is assumed.

³The listed chronic LOC was exceeded for fish and mammals. Therefore, the potential for adverse effects to those species that rely on a specific animal species (specifically fish and/or mammals) or multiple animal species (specifically fish and/or mammals) cannot be precluded. Indirect effects may include general habitat modification,

loss of pollinators/seed dispersers, and food supply disruption.

At this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed new uses of dicamba, since there is a potential for indirect effects to taxa that might rely on plants, birds, aquatic animals, and/or mammals for some stage of their life-cycle. A complete co-occurrence analysis could not be completed for listed species at this time, since the specific use site associated with the proposed new use of dicamba (dicamba-tolerant soybeans). Therefore, without further refinement, no species currently listed as federally threatened or endangered can be excluded from the potential for adverse effects from the proposed new use of dicamba. Details regarding the environmental fate, ecological effects and ecological risks associated with the proposed new uses of dicamba are discussed in the sections that follow.

UNCERTAINTIES

There is a lack of data on the effect of dicamba to green algae as well as a lack of data on chronic effects of dicamba to freshwater and saltwater fish and invertebrates. In the absence of data, risk to these taxa has been assumed.

Based on the usage of other herbicides associated with genetically modified crops that are tolerant to a specific herbicide (*e.g.*, glyphosate-tolerant soybean), the use of dicamba on soybeans [lbs acid equivalent (a.e.)/year] could potentially increase when compared to past usage data from this new use. This is due to a variety of factors including the fact that once a tolerant crop is grown in a particular area, the use of the tolerant crop is often adopted by neighbors (to minimize the potential risk from spray drift). Additionally, dicamba use on tolerant soybeans is predicted to increase given the recent resistance issues identified in glyphosate-tolerant soybean (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Although EFED does not typically address specific concerns related to the increased usage of a chemical, the potential for ecological risks likely increases with increased usage. BEAD should be consulted on the potential for increase use.

Additionally, applications during a warmer time (*i.e.*, post-emergence) may increase off-site transport (via volatility) during a time when many plants have leafed out (J. Tooker, D. Mortensen, and F. Egan, pers. comm., Nov. 2010; Mortensen 2010). Therefore, a post-emergence application may increase the likelihood of effects to non-target plants through habitat loss. This could indirectly affect those organisms which rely on those plants, including pollinators, through this is uncertain and requires additional evaluation.

It is also possible that the proposed new use of dicamba on dicamba-tolerant soybeans may increase the occurrence of weeds that are resistant to dicamba. The occurrence of weed resistance to glyphosate has increased significantly since the adoption of transgenic glyphosate-resistant crops (Powles, 2008). Prior to development of glyphosate-resistant crops, there were no known cases of evolved glyphosate-resistant weeds (Dyer, 1994). There exists potential that a similar pattern of rapidly evolving weed resistance to dicamba could occur where transgenic dicamba-resistant crops are used.

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APPENDIX I

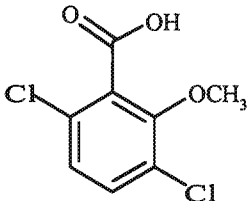
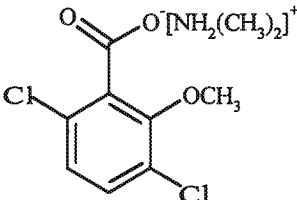
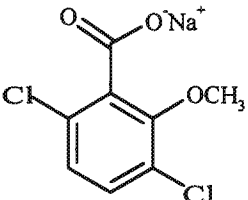
Table 1: Chemical Structures for Dicamba and its Salts	
PC Code 029801	
Chemical structure	
Common name	Dicamba acid
Molecular Formula	$C_8H_6Cl_2O_3$
Molecular Weight	221.04
IUPAC name	3,6-dichloro- <i>o</i> -anisic acid
CAS name	3,6-dichloro-2-methoxybenzoic acid or 2-methoxy-3,6-dichlorobenzoic acid
CAS #	1918-00-9
PC Code 029802	
Chemical structure	
Common name	Dicamba dimethylamine salt (DMA salt)
Molecular Formula	$C_{10}H_{13}Cl_2NO_3$
Molecular Weight	266.1
CAS #	2300-66-5
PC Code 029806	
Chemical structure	
Common name	Dicamba sodium salt (Na salt)
Molecular Formula	$C_8H_5Cl_2NaO_3$
Molecular Weight	243.0
CAS #	1982-69-0
PC Code 128931	

Table 1: Chemical Structures for Dicamba and its Salts

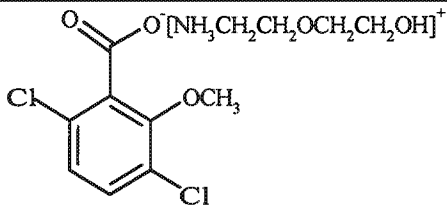
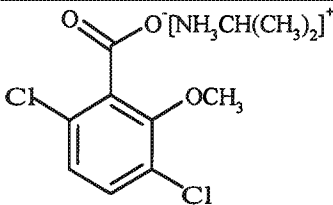
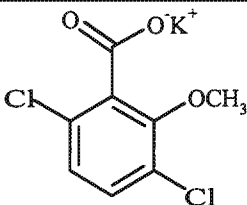
Chemical structure	
Common name	Dicamba diglycolamine salt (DGA salt)
Molecular Formula	C ₁₂ H ₁₇ Cl ₂ NO ₅
Molecular Weight	326.18
CAS #	104040-79-1
PC Code 128944	
Chemical structure	
Common name	Dicamba isopropylamine salt (IPA salt)
Molecular Formula	C ₁₁ H ₁₅ Cl ₂ NO ₃
Molecular Weight	280.15
CAS #	55871-02-8
PC Code 129043	
Chemical structure	
Common name	Dicamba potassium salt (K salt)
Molecular Formula	C ₈ H ₅ Cl ₂ KO ₃
Molecular Weight	259.1
CAS #	10007-85-9

Table 2. Maximum Percent Formation of Dicamba Degradates Observed in the Laboratory and Field Studies							
Degradate	Max Degradate Concentration (% of applied)						
	Hydrolysis	Aqueous Photolysis	Soil Photolysis	Aerobic Soil Metabolism	Anaerobic Aquatic Degradation	Aerobic Aquatic Degradation	TFD
DCSA				17.4% (7 days) (MRID 43245207)	61.6% in soil/water system (MRID 43245208)	8.6% (30 days) water 26% (41 days) soil (MRID 43758509)	present
DCGA					3.64% in soil/water system		not detected
5-OH-Dicamba				0.8%	1.9% in soil/water system		not detected
2,5-DiOH-Dicamba				2.7%			not detected

APPENDIX II

Modeling Dicamba applied aerially on MS Soybean

stored as DicamMSsoybeanPDgr.out

Chemical: Dicamba

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	3.195	3.145	2.943	2.516	2.225	0.9442
1962	5.396	5.332	5.01	4.23	3.702	1.587
1963	12.08	11.87	11.58	10.37	9.189	3.823
1964	5.363	5.289	4.962	4.226	3.711	1.944
1965	1.591	1.57	1.474	1.29	1.159	0.66
1966	12.54	12.38	11.79	10.4	9.286	3.859
1967	16.2	15.97	15.01	13.07	11.6	5.425
1968	7.467	7.396	6.957	5.96	5.242	2.977
1969	48.76	48.28	45.97	39.81	35.09	14.15
1970	11.28	11.1	10.43	9.477	8.454	5.163
1971	38.87	38.42	36.97	32.31	28.59	11.79
1972	6.122	6.027	5.675	5.185	4.781	3.216
1973	51.33	50.79	49.22	43.39	38.3	15.18
1974	21.51	21.25	20.05	17.24	15.32	7.924
1975	7.27	7.187	6.761	5.757	5.074	2.977
1976	4.089	4.033	3.884	3.537	3.171	1.621
1977	15.79	15.62	14.78	12.57	11.01	4.514
1978	8.735	8.624	8.323	7.436	6.6	3.148
1979	9.771	9.625	9.314	8.364	7.481	3.405
1980	28.71	28.38	26.91	22.96	20.02	8.069
1981	3.741	3.725	3.654	3.479	3.32	2.006
1982	16.96	16.75	16.25	14.06	12.41	5.057
1983	3.7	3.645	3.438	2.989	2.802	1.812
1984	8.018	7.894	7.713	6.93	6.174	2.653
1985	6.5	6.417	6.104	5.255	4.64	2.184
1986	1.813	1.783	1.682	1.591	1.459	0.8394
1987	3.864	3.806	3.625	3.072	2.692	1.175
1988	24.89	24.58	23.15	19.85	17.43	6.966
1989	14.08	13.9	13.02	11.09	9.77	4.864
1990	19.66	19.43	18.39	15.9	13.94	6.067

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	51.33	50.79	49.22	43.39	38.3	15.18
0.0645161290322581	48.76	48.28	45.97	39.81	35.09	14.15
0.0967741935483871	38.87	38.42	36.97	32.31	28.59	11.79
0.129032258064516	28.71	28.38	26.91	22.96	20.02	8.069
0.161290322580645	24.89	24.58	23.15	19.85	17.43	7.924
0.193548387096774	21.51	21.25	20.05	17.24	15.32	6.966
0.225806451612903	19.66	19.43	18.39	15.9	13.94	6.067
0.258064516129032	16.96	16.75	16.25	14.06	12.41	5.425
0.290322580645161	16.2	15.97	15.01	13.07	11.6	5.163
0.32258064516129	15.79	15.62	14.78	12.57	11.01	5.057
0.354838709677419	14.08	13.9	13.02	11.09	9.77	4.864
0.387096774193548	12.54	12.38	11.79	10.4	9.286	4.514
0.419354838709677	12.08	11.87	11.58	10.37	9.189	3.859
0.451612903225806	11.28	11.1	10.43	9.477	8.454	3.823
0.483870967741936	9.771	9.625	9.314	8.364	7.481	3.405
0.516129032258065	8.735	8.624	8.323	7.436	6.6	3.216
0.548387096774194	8.018	7.894	7.713	6.93	6.174	3.148
0.580645161290323	7.467	7.396	6.957	5.96	5.242	2.986
0.612903225806452	7.27	7.187	6.761	5.757	5.074	2.977
0.645161290322581	6.5	6.417	6.104	5.255	4.781	2.653
0.67741935483871	6.122	6.027	5.675	5.185	4.64	2.184
0.709677419354839	5.396	5.332	5.01	4.23	3.711	2.006
0.741935483870968	5.363	5.289	4.962	4.226	3.702	1.944
0.774193548387097	4.089	4.033	3.884	3.537	3.32	1.812

0.806451612903226	3.864	3.806	3.654	3.479	3.171	1.621
0.838709677419355	3.741	3.725	3.625	3.072	2.802	1.587
0.870967741935484	3.7	3.645	3.438	2.989	2.692	1.175
0.903225806451613	3.195	3.145	2.943	2.516	2.225	0.9442
0.935483870967742	1.813	1.783	1.682	1.591	1.459	0.8394
0.967741935483871	1.591	1.57	1.474	1.29	1.159	0.66
0.1	37.854	37.416	35.964	31.375	27.733	11.4179
Average of yearly averages:						4.53362

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DicamMSsoybeanPDgr

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: Dicamba

Description	Variable Name	Value	Units	Comments
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Molecular weight	mw	221	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	
Solubility	sol	6100	mg/L	
Kd	Kd		mg/L	
Koc	Koc	13.4	mg/L	
Photolysis half-life	kdp	105	days	Half-life
Aerobic Aquatic Metabolism	kbacw	72.9	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	423	days	Halfife
Aerobic Soil Metabolism	asm	18	days	Halfife
Hydrolysis:	pH 5	0	days	Half-life
Hydrolysis:	pH 7	0	days	Half-life
Hydrolysis:	pH 9	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	1.12	kg/ha	
Application Efficiency:	APPEFF	0.99	fraction	
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	16-04	dd/mm or dd/mm/yy or dd-mm or dd-mmm	
Interval 1 interval	3	days	Set to 0 or delete line for single app.	
app. rate 1 apprate	0.56	kg/ha		
Interval 2 interval	3	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.56	kg/ha		

Record 17: FILTRA

IPSCND 1

UPTKF

Record 18: PLVKRT

PLDKRT

FEXTRC 0.5

Flag for Index Res. Run IR EPA Pond

Flag for runoff calc. RUNOFF none none, monthly or total(average of entire run)

Modeling DCSA from Dicamba applied via ground on MS Soybean

stored as DCSAMSSoybeanPD.out

Chemical: DCSA

PRZM environment: MSsoybeanSTD.txt modified Tuesday, 26 August 2008 at 06:16:40

EXAMS environment: pond298.exv modified Tuesday, 26 August 2008 at 06:14:08

Metfile: w03940.dvf modified Tuesday, 26 August 2008 at 06:14:14

Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.4857	0.456	0.3607	0.2974	0.2768	0.1214
1962	0.4204	0.3977	0.3476	0.26	0.2205	0.1292
1963	0.4554	0.4319	0.3631	0.3058	0.2959	0.1733
1964	1.794	1.691	1.339	0.9315	0.7746	0.3625
1965	0.2641	0.2637	0.2613	0.2549	0.2493	0.1673
1966	1.569	1.516	1.312	1.104	0.9609	0.4516
1967	2.399	2.281	1.973	1.573	1.345	0.6988
1968	1.263	1.218	1.119	0.9311	0.811	0.5318
1969	2.197	2.086	1.722	1.258	1.057	0.5596

1970	0.7601	0.728	0.6233	0.5022	0.451	0.3258
1971	2.736	2.601	2.353	1.972	1.657	0.7538
1972	1.099	1.052	1	0.7875	0.6824	0.4672
1973	2.711	2.611	2.242	1.775	1.486	0.7053
1974	0.9504	0.915	0.7939	0.69	0.6292	0.4341
1975	1.589	1.503	1.298	1.012	0.8664	0.4646
1976	1.438	1.367	1.228	0.9746	0.8417	0.4763
1977	1.088	1.039	0.8804	0.6684	0.5829	0.3699
1978	1.36	1.291	1.196	0.9029	0.7588	0.4023
1979	1.502	1.423	1.288	1.046	0.9341	0.5168
1980	1.899	1.81	1.648	1.408	1.19	0.619
1981	1.072	1.024	0.9449	0.7578	0.6585	0.4295
1982	2.189	2.075	1.823	1.319	1.159	0.5977
1983	2.088	1.993	1.646	1.207	1.01	0.5655
1984	1.153	1.099	0.9339	0.7359	0.6511	0.4228
1985	0.3574	0.3475	0.317	0.27	0.2617	0.2047
1986	1.158	1.089	0.8878	0.6305	0.5289	0.2581
1987	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
1988	1.379	1.307	1.064	0.7544	0.6282	0.3171
1989	1.823	1.729	1.541	1.297	1.111	0.5428
1990	1.513	1.439	1.221	1.001	0.8629	0.5036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
0.032258064516129	2.736	2.611	2.353	1.972	1.657	0.7538
0.0645161290322581	2.711	2.601	2.242	1.775	1.486	0.7053
0.0967741935483871	2.399	2.281	1.973	1.573	1.345	0.6988
0.129032258064516	2.197	2.086	1.823	1.408	1.19	0.619
0.161290322580645	2.189	2.075	1.722	1.319	1.159	0.5977
0.193548387096774	2.088	1.993	1.648	1.297	1.111	0.5655
0.225806451612903	1.899	1.81	1.646	1.258	1.057	0.5596
0.258064516129032	1.823	1.729	1.541	1.207	1.01	0.5428
0.290322580645161	1.794	1.691	1.339	1.104	0.9609	0.5318
0.32258064516129	1.589	1.516	1.312	1.046	0.9341	0.5168
0.354838709677419	1.569	1.503	1.298	1.012	0.8664	0.5036
0.387096774193548	1.513	1.439	1.288	1.001	0.8629	0.4763
0.419354838709677	1.502	1.423	1.228	0.9746	0.8417	0.4672
0.451612903225806	1.438	1.367	1.221	0.9315	0.811	0.4646
0.483870967741936	1.379	1.307	1.196	0.9311	0.7746	0.4516
0.516129032258065	1.36	1.291	1.119	0.9029	0.7588	0.4341
0.548387096774194	1.263	1.218	1.064	0.7875	0.6824	0.4295
0.580645161290323	1.158	1.099	1	0.7578	0.6585	0.4228
0.612903225806452	1.153	1.089	0.9449	0.7544	0.6511	0.4023
0.645161290322581	1.099	1.052	0.9339	0.7359	0.6292	0.3699
0.67741935483871	1.088	1.039	0.8878	0.69	0.6282	0.3625
0.709677419354839	1.072	1.024	0.8804	0.6684	0.5829	0.3258
0.741935483870968	0.9504	0.915	0.7939	0.6305	0.5289	0.3171
0.774193548387097	0.7601	0.728	0.6233	0.5022	0.451	0.2581
0.806451612903226	0.5557	0.5283	0.4466	0.3983	0.3662	0.2322
0.838709677419355	0.4857	0.456	0.3631	0.3058	0.2959	0.2047
0.870967741935484	0.4554	0.4319	0.3607	0.2974	0.2768	0.1733
0.903225806451613	0.4204	0.3977	0.3476	0.27	0.2617	0.1673
0.935483870967742	0.3574	0.3475	0.317	0.26	0.2493	0.1292
0.967741935483871	0.2641	0.2637	0.2613	0.2549	0.2205	0.1214

0.1 2.3788 2.2615 1.958 1.5565 1.3295 0.69082
Average of yearly averages: 0.42682

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:

Output File: DCSAMSSoybeanPD

Metfile: w03940.dvf

PRZM scenario: MSsoybeanSTD.txt

EXAMS environment file: pond298.exv

Chemical Name: DCSA

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	207	g/mol	
Henry's Law Const.	henry	1.6E-9	atm-m ³ /mol	
Vapor Pressure	vapr	3.41E-5	torr	

Solubility	sol	2112	mg/L			
Kd	Kd		mg/L			
Koc	Koc	1208	mg/L			
Photolysis half-life	kdp	105	days	Half-life		
Aerobic Aquatic Metabolism	kbacw	49.2	days	Halfife		
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife		
Aerobic Soil Metabolism	asm	24.6	days	Halfife		
Hydrolysis:	pH 5	0	days	Half-life		
Hydrolysis:	pH 7	0	days	Half-life		
Hydrolysis:	pH 9	0	days	Half-life		
Method:	CAM	1	integer	See PRZM manual		
Incorporation Depth:	DEP1		cm			
Application Rate:	TAPP	0.18	kg/ha			
Application Efficiency:	APPEFF	1.0	fraction			
Spray Drift	DRFT	0	fraction of application rate applied to pond			
Application Date	Date	16-04	dd/mm or dd/mm or dd-mm or dd-mmm			
Interval 1	interval	3	days	Set to 0 or delete line for single app.		
app. rate 1	apprate	0.09	kg/ha			
Interval 2	interval	3	days	Set to 0 or delete line for single app.		
app. rate 2	apprate	0.09	kg/ha			
Record 17: FILTRA						
	IPSCND	1				
	UPTKF					
Record 18: PLVKRT						
	PLDKRT					
	FEXTRC	0.5				
Flag for Index Res. Run	IR		EPA Pond			
Flag for runoff calc.	RUNOFF	none	none, monthly or total(average of entire run)			

APPENDIX III: Environmental Fate and Transport Database Dicamba Acid (and its Salts):

GUIDELINE NUMBER	DESCRIPTION	ACTIVE INGREDIENT	CITATION	CLASSIFICATION
835.2120	Hydrolysis	Dicamba acid	40335501	Acceptable
835.2240	Photodegradation in Water	Dicamba acid	42774102	Acceptable
835.2410	Photodegradation on Soil	Dicamba acid	42774103	Acceptable
835.2370	Photodegradation in Air	No data available	N/A	N/A
835.4100	Aerobic Soil Metabolism	Dicamba acid	43245207	Acceptable
835.4200	Anaerobic Soil Metabolism	Dicamba acid	43245208	Acceptable
835.4400	Anaerobic Aquatic Metabolism	Dicamba acid	43245208	Acceptable
835.4300	Aerobic Aquatic Metabolism	Dicamba acid	43758509	Supplemental
835.1230	Leaching Adsorption/Desorption	Dicamba acid Dicamba acid	42774101 43095301	Acceptable Supplemental
835.1410	Laboratory Volatility	K and DMA salts	41966602	Acceptable
835.8100	Field Volatility	No data available	N/A	N/A
835.6100	Terrestrial Field Dissipation	Sodium and Diglycoamine salts Diglycoamine salt Dimethylamine salt Diglycoamine salt Sodium salt Potassium salt Potassium salt	43361506 43361507 43651405 43651407 43651408 42754101 42754102	Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental Supplemental
835.6200	Aquatic Field Dissipation	No data available	N/A	N/A
835.6300	Forestry Dissipation	No data available	N/A	N/A
850.1730	Accumulation in Fish	Study waived	N/A	N/A
850.1950	Accumulation Aquatic non-target organisms	No data available	N/A	N/A
835.7100	Ground Water- small prospective	No data available	N/A	N/A
166-2	Groundwater-small retrospective	No data available	N/A	N/A
201-1	Droplet Size Spectrum	No data available	N/A	N/A
202-1	Drift Field Evaluation	No data available	N/A	N/A

APPENDIX IV: T-REX Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Upper Bound Kenaga Residues For RQ Calculation

Chemical Name:	0
Use	0
Formulation	0
Application Rate	1 lbs a.i./acre
Half-life	35 days
Application Interval	0 days
Maximum # Apps./Year	1
Length of Simulation	1 year

Endpoints			
Avian	Bobwhite quail	LD50 (mg/kg-bw)	188.00
	Bobwhite quail	LC50 (mg/kg-diet)	0.00
	Mallard duck	NOAEL(mg/kg-bw)	0.00
	Mallard duck	NOAEC (mg/kg-diet)	800.00
Mammals		LD50 (mg/kg-bw)	2740.00
		LC50 (mg/kg-diet)	0.00
		NOAEL (mg/kg-bw)	45.00
		NOAEC (mg/kg-diet)	900.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	240.00
Tall Grass	110.00
Broadleaf plants/sm Insects	135.00
Fruits/pods/seeds/lg insects	15.00

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
20	135.44	273.34	2.02	125.28	0.92	153.75	1.14	17.08	0.13	3.80	0.03
100	172.42	155.87	0.90	71.44	0.41	87.68	0.51	9.74	0.06	2.16	0.01
1000	243.55	69.78	0.29	31.98	0.13	39.25	0.16	4.36	0.02	0.97	0.00
Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients											

NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
800	240.00	0.30	110.00	0.14	135.00	0.17	15.00	0.02

Size class not used for dietary risk quotients

Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	6022.06	228.82	0.04	104.88	0.02	128.71	0.02	14.30	0.00	3.18	0.00
35	4872.49	158.15	0.03	72.48	0.01	88.96	0.02	9.88	0.00	2.20	0.00
1000	2107.50	36.67	0.02	16.81	0.01	20.63	0.01	2.29	0.00	0.51	0.00

Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients									
NOAEC (ppm)	EECs and RQs								
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	
900	240.00	0.27	110.00	0.12	135.00	0.15	15.00	0.02	

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EE C	RQ
15	98.90	228.82	2.31	104.88	1.06	128.71	1.30	14.30	0.14	3.18	0.03
35	80.02	158.15	1.98	72.48	0.91	88.96	1.11	9.88	0.12	2.20	0.03
1000	34.61	36.67	1.06	16.81	0.49	20.63	0.60	2.29	0.07	0.51	0.01

APPENDIX V: TerrPlant Inputs and Outputs for Dicamba Use on Dicamba-Tolerant Soybeans.

Table 1. Chemical Identity.	
Chemical Name	Diglycolamine salt (DGA) of Dicamba
PC code	128931
Use	Dicamba-Tolerant Soybeans
Application Method	Foliar
Application Form	Liquid
Solubility in Water (ppm)	6100

Table 2. Input parameters used to derive EECs.			
Input Parameter	Symbol	Value	Units
Application Rate	A	1	
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Diglycolamine salt (DGA) of Dicamba. Units in .		
Description	Equation	EEC
Runoff to dry areas	$(A/I)*R$	0.05
Runoff to semi-aquatic areas	$(A/I)*R*10$	0.5
Spray drift	$A*D$	0.01
Total for dry areas	$((A/I)*R)+(A*D)$	0.06
Total for semi-aquatic areas	$((A/I)*R*10)+(A*D)$	0.51

Table 4. Plant survival and growth data used for RQ derivation. Units are in .				
Plant type	Seedling Emergence		Vegetative Vigor	
	EC25	NOAEC	EC25	NOAEC
Monocot	1.68	0.64	0.472	0.137
Dicot	0.123	0.0673	0.000513	0.000013

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to Diglycolamine salt (DGA) of Dicamba through runoff and/or spray drift.*				
Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	non-listed	<0.1	0.30	<0.1
Monocot	listed	<0.1	0.80	<0.1
Dicot	non-listed	0.49	4.15	19.49
Dicot	listed	0.89	7.58	769.23

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
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To: Goodis, Michael [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=50ed0b92dc4945b7a808fe8dbc9224f0-Michael Goodis]
Subject: letter
Attachments: Draft letter.docx

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REUBEN BARIS | ACTING CHIEF | HERBICIDE BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF PESTICIDE PROGRAMS | (703) 305-7356

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From: Rowland, Grant [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=5B004BC79F1F40B0A181A584A8C64495-ROWLAND, GRANT]
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Subject: This should work
Attachments: 128931_425049_Phase 3+4 States ESA Assessment_Final Draft 3-14-16.docx; 128931_416416+_ESA Phase 1 Assessment_3-8-16_Final Draft.docx; 128931_422305_Phase 2 States ESA Assessment_3-9-16_Final Draft.docx; Dicamba (GE) proposed decision cotton and soybeans (Draft).docx; Final Registration of Enlist Duo Herbicide - 10-14-14.doc

*Grant Rowland
Herbicide Branch
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Message

From: Baris, Reuben [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=A0181E3F02A246FC915A4AF026E249FC-BARIS, REUBEN]
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To: Perlis, Robert [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b74bb55bb480452d99e3e4fd07c06889-RPERLIS]
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Attachments: Dicamba Changes for Registrant (internal use only).docx

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Attached as requested. Call me if you want to discuss status.

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